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Power Plant ENGINEERING

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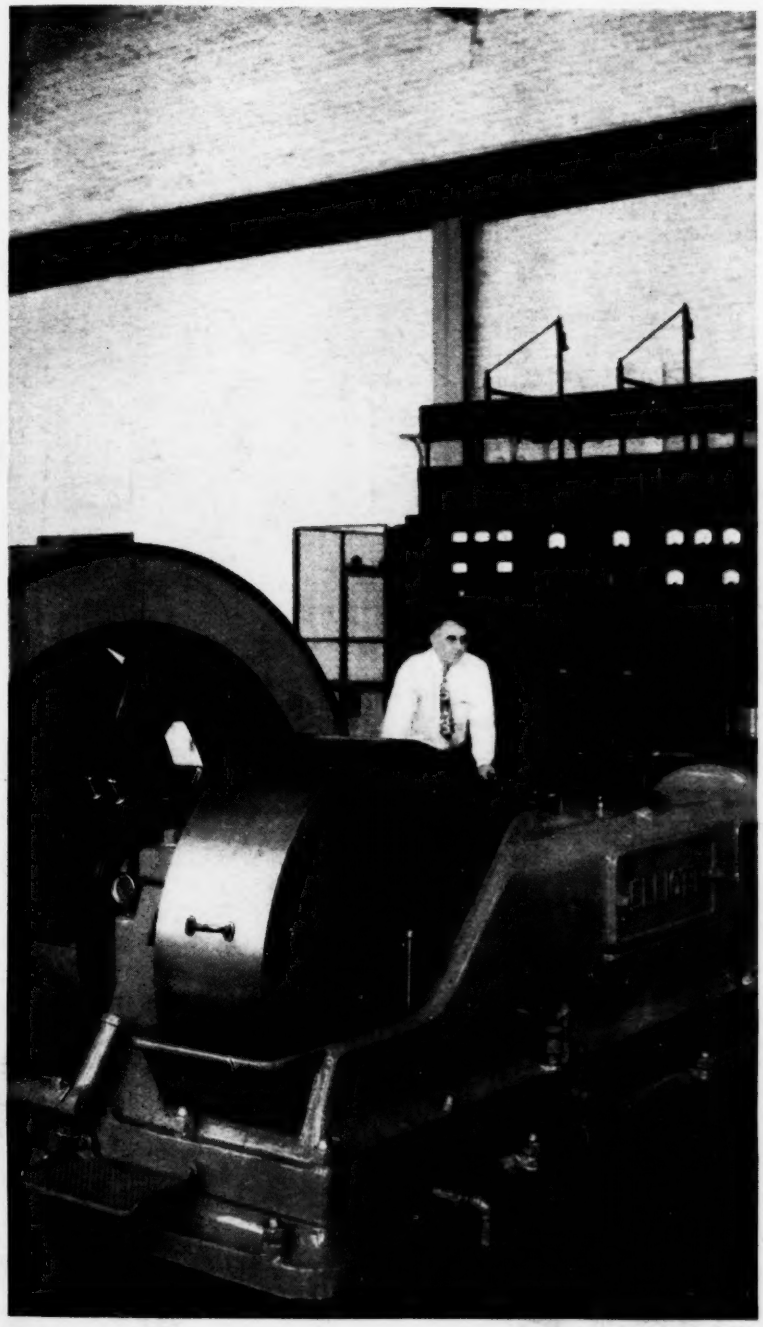

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COVER: ONE OF TWO 500-KVA ELLIOTT FOUR-VALVE ENGINE-GENERATOR UNITS IN THE PLANT OF THE MANTENO STATE HOSPITAL, MANTENO, ILL. THERE IS ALSO A THIRD FOUR-VALVE ENGINE-GENERATOR UNIT RATED 250 KVA. ENGINE-GENERATORS WERE INSTALLED IN 1935. IN 1941, TO MEET INCREASED LOAD DEMANDS, AN ELLIOTT 1250-KVA TURBINE-GENERATOR UNIT WAS INSTALLED. ALL UNITS ARE NONCONDENSING AND SUPPLY EXHAUST STEAM FOR HEATING.

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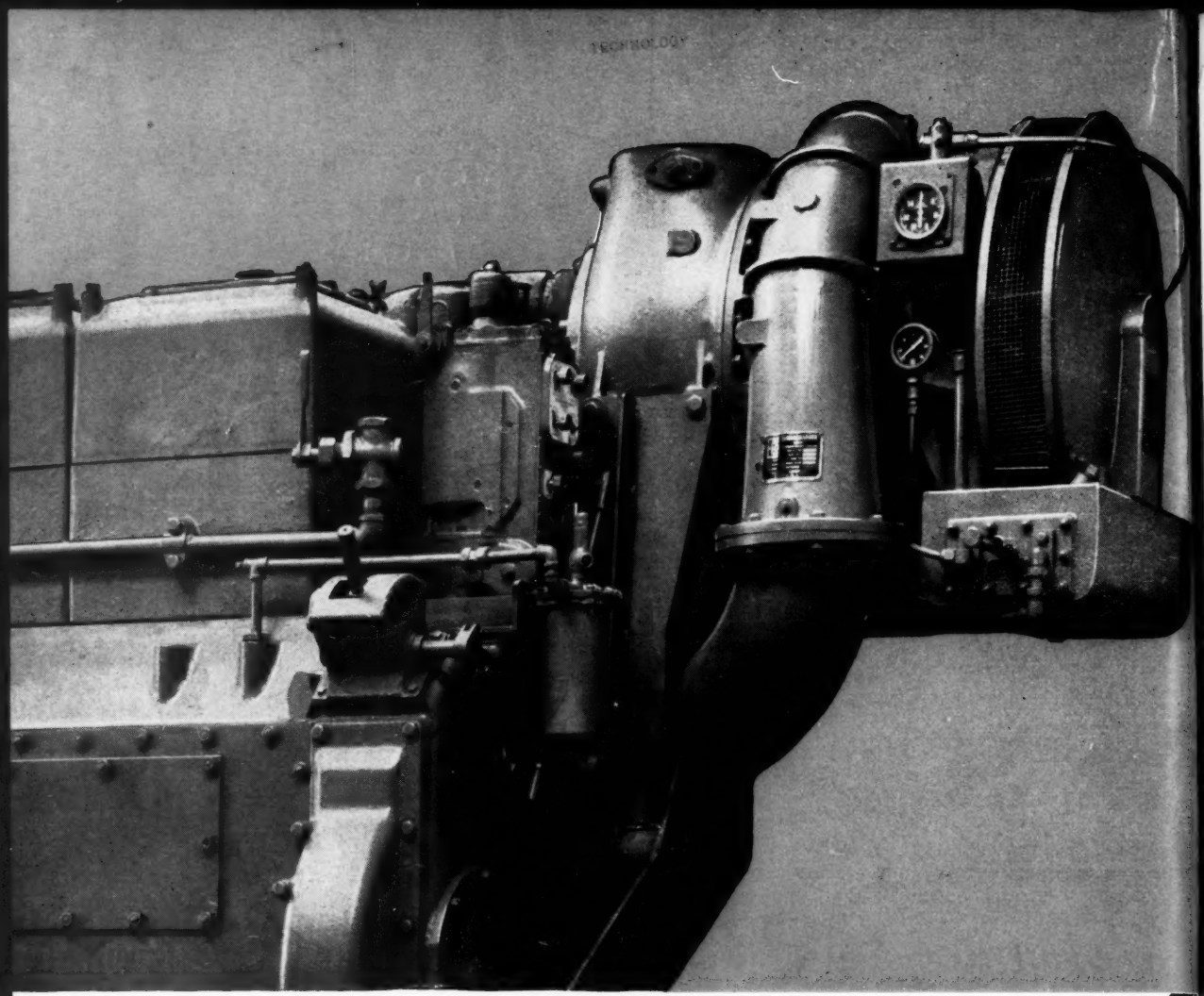
THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

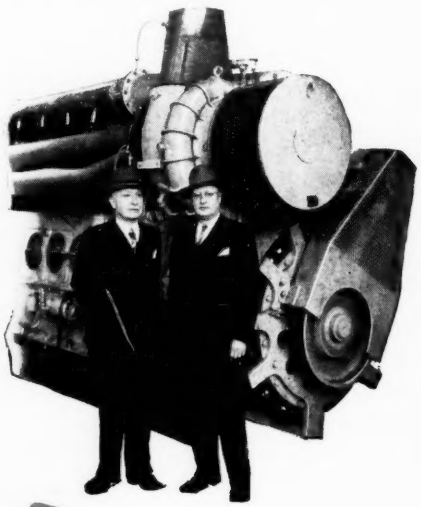
JULY, 1947



DISTINGUISHED VISITOR

DR ALFRED J. BUCHI of Switzerland, who conceived and developed the Buchi system of turbocharging, has been in the United States for several months. He is shown (left) with C. F. Harms, manager of the supercharger department of Elliott Company, in the plant of the Baldwin Locomotive Works. Dr. Buchi and Mr. Harms made an extended tour among the builders of four-cycle engines in the interest of better application of turbochargers.

Dr. Buchi was effective in starting the use of the Buchi system in Europe just after World War 1. Although America did not take it up until shortly before World War II, American production already exceeds European.



Elliott BUCHI

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Power Plant ENGINEERING

July, 1947

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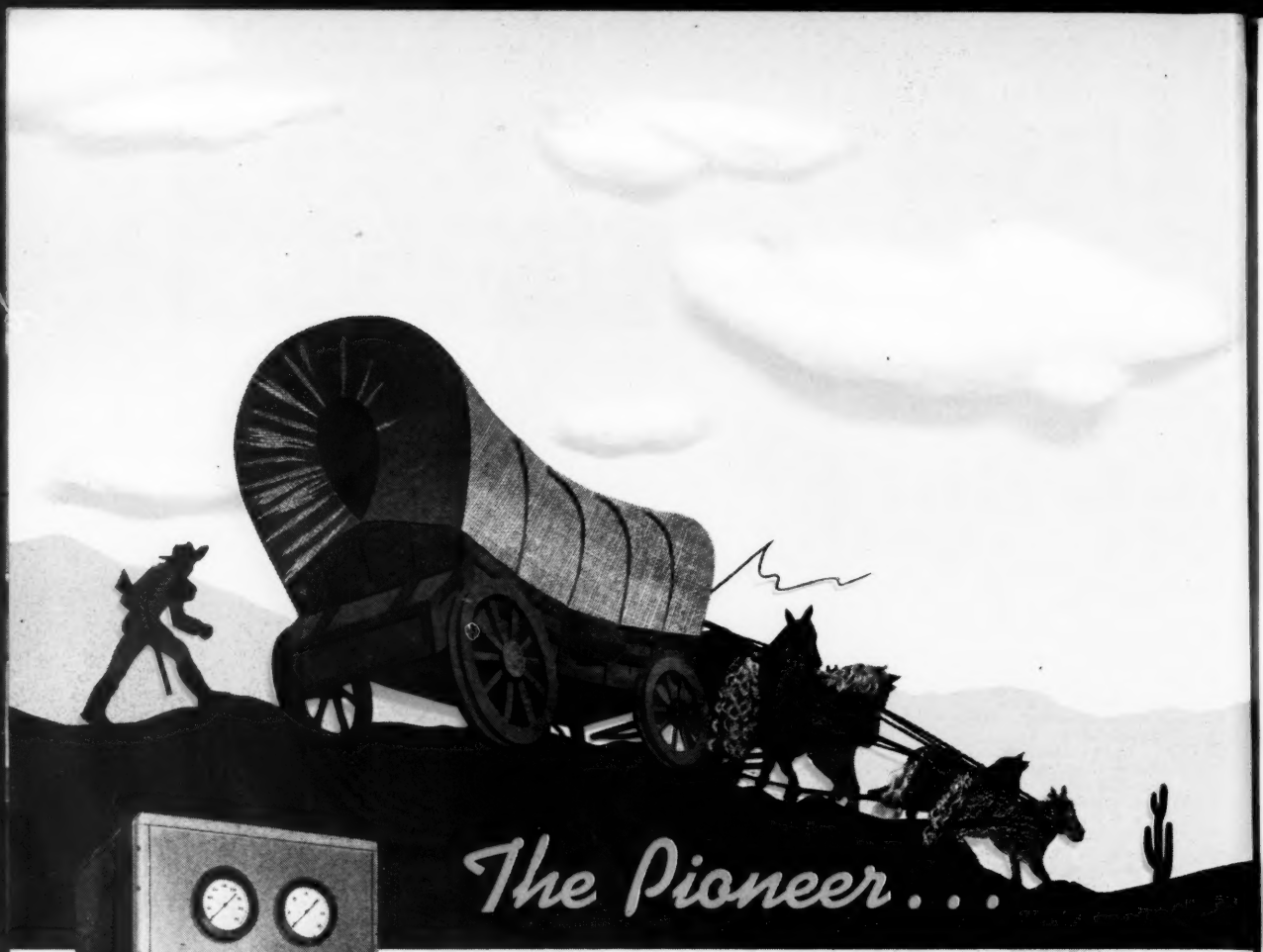

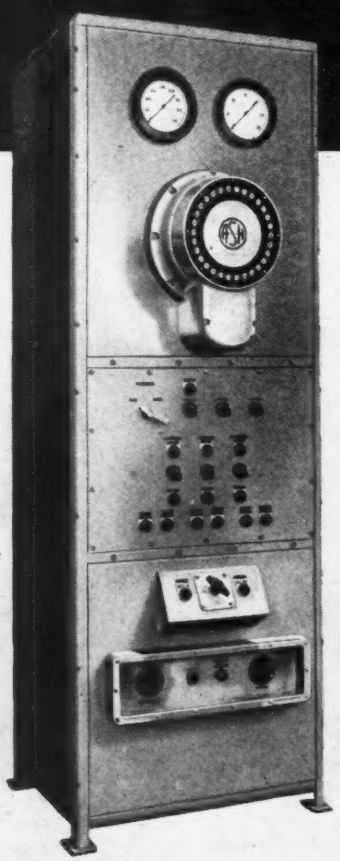

AUTOMATIC DUST HANDLING SYSTEM

. . . HYDROVAC

Our trek into the unexplored unknown of automatic dust handling began over ten years ago. We sought the ultimate . . . a system that seemingly "thinks for itself" . . . one with the uncanny reliability that is foolproof. . . . Success, in rewarding our pioneering quest, has uncovered a surprise economy bonanza because "time has more effect on wear than tonnage." Continuous, top-speed operation of automatic dust removal reduces all maintenance, particularly pipeline. . . . The Automatic Sequence Head (pictured at left, patents pending) is, as its name implies, the head or brain controlling this Hydrovac System. It opens and closes dust valves, skips over boilers off the line, warns of unusual conditions, tells what is happening all the time, and closes the system when all dust is removed. . . . Get the complete story from our representative, then you'll agree it's more than a sound investment. . . . The Allen-Sherman-Hoff Company, 233 S. 15th Street, Philadelphia 2, Pa.

AUTOMATIC
AUTOMATIC
ALLEN

SEQUENCE
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HEAD
HOFF

ENGINEERS' PREVIEW

GIVING WING-NUT convenience and quickness with positive locking, new self-locking wing nut with elastic nylon locking collar is available for fine thread 8/36, 10/32, 12/28, fractional 1/4-28 machine screws, and coarse thread 8/32, 10/24, 12/24 and fractions 1/4-20. Die-cast zinc in plain finish, nickel plating extra. Suggested for cars, trucks, machinery, industrial equipment.

★ ★ ★

CARBO TANK coatings, to protect storage tanks and tank cars during loading, shipping, unloading, cleaning, are claimed to increase their life. Afford high resistance to gasoline, oils, greases, sunlight, rain, snow, sleet, tars, caustics, acids, other generally-destructive agents. Non-bleeding, fully suspended in quick-drying vehicle, highly-resistant to abrasion and temperatures to 300 F.

★ ★ ★

FOR PRESSURES to 125 psi, combined water column and boiler water level controller is designed to give advantages of easy installation, elimination of cross-over piping, one blowdown instead of two. Models available for pressures up to 250 psi.

★ ★ ★

TO DIFFUSE fluorescent lighting, Tulox tenite tubing has been developed in transparent orange, yellow, red, rose, green, blue and clear to fit standard T-5, T-6, T-8 and T-12 lamps, installed by slipping over fluorescent bulbs. Inner wall consists of longitudinal prisms to diffuse light, spacer splines to support tube on lamp; exterior is smooth.

★ ★ ★

LIGHTWEIGHT prefabricated belt conveyor has chain, belt, sprockets, channels, angles, frames fabricated of high-test aluminum alloy providing adequate strength, rust and corrosion, acid, chemical and fume resistance. Widths 6-60 in., heights 15 in., capacity 250 lb per sq ft, any speed to 100 fpm. Successful in food industries, usable wherever its light weight, other qualities are desirable.

★ ★ ★

SCHOOL won't be the same when this type of instruction becomes commonplace. One of the largest firms in the educational publishing field has recently announced a remarkable new teaching aid unit for high schools and colleges. The unit consists of a textbook, 16-mm sound motion pictures and silent film strips. The textbook is the basic source of information, while the films are correlated with the book, using the same approach to the subject and same terminology.—*The Ohmite News.*

★ ★ ★

ALTHOUGH contact rectifiers of the vibrating type have been used in this country for low power applications for years, the Germans had units with outputs of 60,000-kw and an efficiency as high as 99 per cent at one-quarter to full load. The contact rectifier is a synchronous-motor-driven mechanical system, which breaks alternating current each half cycle and delivers the positive and negative halves of the cycle to separate terminals, thus furnishing a unidirectional current. For full details of how it works, see page 107, this issue.

NEW LIMIT SWITCH has self-contained contact mechanism, in gasketed die-cast enclosure, to make possible high electrical rating, long mechanical life in minimum size. Surface and mounting arrangements available with roller-arm or push-rod-operated mechanisms. Oil and dust tight enclosure is mountable in several positions; 1/2-in. conduit entrance can be at either end by rotating cover and switch assembly 180 deg. Roller-arm types operate with 5-deg. travel; 25 deg. overtravel in both directions provided. Can be adjusted to any position around circle. Return springs may be reversed for clockwise or counterclockwise lever motion, or removed for maintenance contact action. Operating arms available in 7/8-3-in. lengths; rollers 3/8-in. diameter, 1/4-in. wide. Push-rod mechanism designed for straight-line operation is not recommended for side thrusts.

★ ★ ★

NEW METALLIC SOAPS proved efficient cleansers without grease, are used as lubricants; others act as friction agents, disperse organic liquid with gel formation, destroy such gels, help lubricating oils stick, free rubber and plastics from sticking. Zinc stearate will retain up to nine times its weight of water when freshly prepared, is difficult to rewet when dried. Some act as fire retardants, as waterproofing agents. Others are emulsifiers, de-emulsifiers, the former including those which form water-in-oil and oil-in-water emulsions. Available are: Aluminum, ammonium, calcium, lead, magnesium, sodium and zinc stearates. These can be had special: Barium, cadmium, cobalt, copper, iron, manganese, mercury, nickel, silver, strontium and tin. Most have unique, or special properties. Thus aluminum stearate, barium and other oleates are used as thickening, hardening, pigment-suspending agents in printing and silk-screen process inks. Aluminum stearate in solvents with small amounts of mineral or animal oils, form fireproof paint solvent. It may also be a constituent of compositions for phosphorescent coatings or for colored-gasoline stabilizer. Magnesium stearate and alcohol form a solid fuel. Calcium stearate on rubber acts as durable frictioning agent for brakes, clutches, shock absorbers. Incorporated in bituminous materials, iron, zinc, aluminum and barium stearates form flame-retardants.

★ ★ ★

PRESS-TO-HEAT soldering tool about the size and shape of an electric shaver, has a spring-actuated lever which, compressed, closes two plier-like carbon electrodes on part being soldered. Further compression switches on current to melt solder. Slight release of pressure cuts off current, allows holding work in jaws until cool. Operates on a-c, uses 6-v. transformer.

★ ★ ★

HYDRAULIC ELEVATORS in standard sizes for freight and passengers, with travel limited to 36 ft., feature new plunger construction, with V-type packing at cylinder head self-adjusting to plunger, to reduce friction and keep pit dry without drip pan. In all except most severe conditions, well-hole casing can be eliminated. Cylinder protection is mastic coating, covered by asphalt-impregnated kraft paper reinforced with nylon cord.

ELECTRICALLY-OPERATED small freight elevator capable of handling 500 lb., called Electravator, operates on screw-lift action to eliminate rails, cables, counterweights. It is powered with 1-hp, 1750-rpm motor to give 35 fpm lift speed, may be installed on side or back wall. Standard model has 15-ft. beam, give 12-ft. lift. Entirely assembled at factory, shipped ready to install with limit switches, all controls, but without car platform or enclosures, which are to be installed locally.

★ ★ ★

A SLIGHTLY-YIELDING concrete floor that absorbs 90 per cent of impact, is warm and dry, has stood up well, with wear-resistance equal to hard maple flooring, in shops, laboratories, farm buildings; is produced at a cost approximately equal to regular 1:2:4 concrete by addition of asphalt emulsion. Aquapels No. 1 emulsion contains vinsol resin to induce limited air entrainment, and to improve workability, impact absorption, thermal properties. Care in mixing is necessary to prevent excessive foaming. Use 7 gal. to the cubic yard, just enough water to make mix glisten without being sloppy. Sharp, exposed edges must be protected.

★ ★ ★

AGRASEAL one-coat protective and sealing compound in white, ivory, cream, light buff, yellow, stone gray, light green, may be applied with scrub brush to cinder or concrete blocks, lightweight aggregates, other surfaces.

★ ★ ★

NEW CYLINDRICAL rectifiers (produced by electro-deposition) are cooled by liquid circulation to give more-efficient heat-dissipation and producing high amperage capacity.

★ ★ ★

KORDLESS KWIKHEAT pencil-type soldering tool for delicate work is heated by screwing heater-receptacle into the company's electric iron with action similar to desk-pen set: insert and use—insert and use. Forged tellurium-copper tip holds temperature at 680 deg F for 1 minute, reheats in 20 seconds.

★ ★ ★

HYFLOW steel industrial oil filter HFC-8 using, according to needs, 1 to 18 filter cartridges (7¼ by 18 in.), is available with or without heater. Oil delivered to inlet is forced from outside of cartridge toward center, through outlet into system. Auxiliary motor-driven pump or direct pressure from engine or equipment. May be operated as by-pass or full-flow filter. Cartridges have Hiltex cellulose to handle additive oils and/or Fullers Earth for straight-run mineral oils; claimed to have micronic filtration and high flow at relatively low pressures.

★ ★ ★

REFRASIL high-silica insulation for jet engine cones, tail pipes, is claimed to be physically efficient, chemically stable, at sustained temperature of 2000 F, safe at higher temperatures for short periods. Available in batts 14 by 3½ ft. by $\frac{3}{16}$ in., in cloth of random lengths 32 by 0.015 in. Silica fibers have no sharp melting point, start to soften at 2300 to 2400 F do not fuse until 3100 F. Said to be unaffected by most acids, so can be used as filter of corrosive liquids and gases. Available experimentally in cordage, sleeving, tape, suggesting many industrial applications. Bulk density 4 lb per cu ft.

FOR NORMALIZING before welding, preheating, etc., new portable induction heater includes Model YP 10-kva unit which may be stacked in 2's for 20 kva, in 3's for 30, etc. The 30-kva group is designed to heat a 10-in. pipe joint to 1300 F in 2 hours. Developed primarily for flexibility and adaptability to wide range of capacities and applications, unit is complete in itself with power unit, contactors, meters and control supply. Built-in selector switch controls heat and voltage output variations. Pyrometer and program controllers can be plugged into two polarized receptacles to record job temperature and control heat cycle. Polarized receptacles also are provided for interconnection of heaters into groups and power supply to the units. Unit can be used for thawing large water lines, testing high-current power-bus connections, supplying loads for testing relays on power systems, resistance heating for brazing and soldering, shrink-fitting, heating for straightening, drying water-soaked rotors and stators, and so on.

★ ★ ★

IN A NEW odorless method of treating burns, reported by F. E. Ludwig in *Surgery*, glycerine finds an important application. In this method, burns are treated with a saline-glycerine-acetic acid solution having a pH of about 3.8. On the basis of use in the treatment of 358 burns, Ludwig gives its advantages as follows: Odor from the burns is eliminated; there is no maceration of the tissue; the hygroscopicity of the glycerine makes the dressing changes easier and apparently stimulates epithelization; the acetic acid prevents pyogenic infection, the burns are cleaned by the solution; the dressings may be changed without anesthesia; and a minimum of grafting is necessary under this method of treatment.

★ ★ ★

IN THE search for better products, better manufacturing processes and a strong position in national and international markets, American business is spending more money for industrial research than in the years immediately preceding the war, according to the National Industrial Conference Board. Increased emphasis is being placed on such activities as product improvement and application, operations' research and testing, research into processes, production methods and planning, equipment, and control. Generally, also, an increased amount of money is being put into pure research. Improvement and redesign of existing products is given somewhat more attention than the development of those new products which represent a radical departure from existing lines. The median percentage of outlays for industrial research among the companies included in the survey falls between 1.5 per cent and 2.0 per cent of the sales dollar. In a few instances, research costs run as high as 5.0 pr cent of the sales dollar, while a minority of companies allocate very little or nothing to research and development. Most companies turn to outside research facilities for assistance. This is true for more than three-quarters of the companies included in the survey. The principal outside facilities used are those of colleges and universities and commercial or independent laboratories. Both are mentioned with about equal frequency. Much less frequently mentioned, but still important, are the research facilities provided by trade associations..

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILERS, BURNING

1 **Automatic Boilers**—Here are two bulletins which describe the company's line of automatic boilers from 3½ hp to 200 hp, pressure from 100 to 150 psi. One of the bulletins is completely devoted to a description of a new line—the Model A—which is available in sizes from 3½ hp to 7½ hp. Each of the bulletins is well illustrated and contains tabular information on specifications, dimensions. Construction of the boilers is well brought out in the many sectional illustrations. Steamaster Automatic Boiler Co.

2 **Combustion Engineering** — Booklet "Opportunities for the Combustion Expert" gives outline of practical home study course in fuel and combustion engineering. Hays Institute of Combustion.

3 **Steam Generators**—This new four-page bulletin points out the advantages of this company's line of steam generators. Among the many features to which the bulletin calls attention are: the combustion method, simple two-pass construction, completely automatic operation, automatic wide-range modulation and operating efficiency. A table of ratings and dimensions is given and several illustrations are published. Cyclotherm Corp.

4 **Ram-Feed Stokers**—Bulletin S-32, 8 pages, describes Types LR and LRI ram feed stokers. Mechanical features of the units are first described and then overall advantages of the units are told. Several good photographs are used for illustrative purposes and a large line drawing shows the unit installed. General information is included. The Brownell Co.

5 **Oil Burning Manual**—Bulletin O-B 37 is a 16-page bulletin covering the installation, construction and operation of oil and gas burners and other burning equipment such as pumping and heating systems for fuel oil. The bulletin is exceptionally well illustrated and arranged. Photos show typical installations and line drawings picture assembly and detail parts. Tables of capacities are presented. The Engineer Co.

ELECTRICAL

6 **Protected Type Motors**—Bulletin SL-300-1, gives information on this company's new protected type motor. A large cutaway illustration of the motor is used as a vehicle for calling attention to the 11 major constructional advantages of the unit. The last page of the folder shows "when and where to use protected type motors." Crocker-Wheeler Div., Joshua Hendy Iron Works.

7 **Distribution Transformers Manual**—Bulletin TU-180, consists of 62 pages of catalog information and technical data on the company's line of distribution transformers. Included in this material is a consolidated price list and complete descriptive data on transformers for 1½ to 500 kva up to 73,000 volts. Catalog information consists of detailed descriptions and listings of parts of units while the engineering information gives installation and operating instructions. Considerable general information on transformers is given in still more engineering data sheets. Wagner Electric Corp.

8 **Circuit Breakers Bulletin**—This new multi-breaker has been designed for apartments, stores, garages, churches, schools, small factories, etc. Features of the unit are described by means of cutaway illustrations which have the various parts labeled. Advantages of the breaker are further described in the accompanying copy. The back portion of the booklet shows the ease with which the breaker may be installed or serviced. Cutler-Hammer, Inc.

9 **Wires and Cables** — Bulletin OK-1013A, 36 pages, bound in a separate heavy paper cover, describes the method of manufacture of these insulated wires and cables. Physical properties of insulation and shielding and tables of recommendation for various kinds of services are given. Tables of ratings at different voltages cover several of the pages while other tables give current carrying capacity of wire and cable. Other tables for computing various constants such as voltage drop, conductor size, circuit length and current are included. Also, instructions for terminating cables are presented, complete with drawings, in the back portion of the booklet. The Okonite Company.

INSTRUMENTS, CONTROLS

10 **pH Indication, Control**—Bulletin 16, 8 pages, describes the features, operation and construction of the company's pH indicator and presents two pages of information and data on "Modern pH Control." The descriptive material is well illustrated and arranged logically to form a running description of the unit. Drawings are given. National Technical Laboratories.

11 **Boiler Water Level Control**—Bulletin 469, 20 pages, describes the company's equipment installed at 12th Street, Reeves Avenue and Chesterfield Stations of Virginia Electric and Power Company. The installation of each station is described separately and the story presents photographs, descriptive information and tables of significant data. Sectional views of the boilers are shown and typical charts are reproduced. Northern Equipment Co.

12 **Thermal Procedure Handbook**—This bulletin on Thermoswitch Controls, 58 pages, has been compiled for the use of engineers concerned with temperature in all industries. The bulletin is extremely well arranged and is printed in several colors for ease in understanding many of the drawings and charts presented. Complete engineering information on the various types of controls is given and installation and operation are covered. Methods of checking the system under operating conditions are described and the special features of the unit are covered. An application questionnaire and price list complete the booklet. Fenwal Inc.

13 **Boiler Water Level Control**—Bulletin 467 is a recently released bulletin describing boiler water level control at Buzzard Point Plant of Potomac Electric Power Co. Photographs of the installation are presented and a complete description of the unit is given. Information of considerable significance are tables of data and reproductions of recording charts. Northern Equipment Co.

14 **Water Level Controls**—Bulletin 147, 4 pages, covers this company's "foolproof" water level control. Line diagrams show positions of the control at operating and low levels and are used in conjunction with the tables for dimensional purposes. A description of the unit's operation and construction is given. Detailed descriptions of various types of unit in the line also are included. Magnetrol, Inc.

15 **Electronic Controls**—This 20-page booklet, Bulletin Z-6400, is a condensed catalog containing information, listings and specifications on the company's standard instruments. Proportioning, automatic positioning and program control are explained with graphs, diagrams and photographs. Various types of controllers, indicating pyrometers and resistance thermometers, input controllers and many other controls are covered. Wheelco Instruments Co.

AUXILIARIES

16 **Refrigeration Handbook** — Bulletin 80-B is a 36-page Data and Handbook of refrigerating practice and a catalog of the manufacturer's equipment. Titles of some of the sections indicate the scope of the book: Principles of Refrigeration; Ice Making Systems; Low Pressure Refrigerating Units; Air Conditioning Systems; Refrigerated Food Lockers; Quick-Freezing Systems, etc. Tables are also included. The equipment described also covers a wide range of types and capacities, from combined ammonia units and Freon-12 and ammonia booster compressors to large four-cylinder compressors and control equipment and valves and fittings. The booklet, throughout, is exceptionally well illustrated and the material is arranged well for easy reference. Frick Co.

17 **Fuel Oil Heaters**—Bulletin 60, 28 pages, describes many types of the company's fuel oil heaters. Principles of operation of the unit and design details are covered completely in the first few pages of the bulletin while the remainder of the booklet is concerned with detailed descriptions of various types of heaters, and with tables of dimensions and weights and sectional dimension drawings. Various types of suction heater

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POWER PLANT ENGINEERING

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installations are shown and described. Oil heater engineering data is given in the last two pages. Davis Engineering Corp.

18 **Manual on Deaerators**—There are 36 pages in this recently-issued Bulletin 3005 on deaerators. Progress in deaeration is concisely outlined and excellent photographs show the various models in the company's line. Descriptions of each of the various types are illustrated and blue-print type drawings show location in the flow diagrams of various plants. Operation of the deaerator is explained with colored drawings. Other similar drawings illustrate various principles. Cochrane Corp.

19 **Dust Collector's Handbook** — Two handbooks covering the problem of dust recovery have just been issued by this company. The first one is concerned with the mechanical dust collector and this booklet contains 32 pages; the second is devoted to the Cottrell electric precipitator and has 28 pages. The problem of recovering dust in industrial operations is covered completely in the first part of the 32-p. booklet. The booklet on the electric precipitator tells of the various types of precipitators and presents exceptionally good drawings and wiring diagrams of these units. A comparison of mechanical and kenotron rectifiers is given. Methods of removal of collected material is told. Nomenclature of the unit is accompanied by line drawings. The back part of the booklet is devoted to an outline of the efficiency of precipitation. Both bulletins are well indexed. Western Precipitation Corp.

TREATMENT, CONDITIONING

20 **Water Conditioning Reprint**—This 4-page article titled, "Boiler Water Conditioning at West Point Power Plant" by Frederic R. Meyers, is being made available by this company upon application. The article formerly appeared in Power Plant Engineering. The article describes complete colloidal tretament without inorganic salts which has been used at West Point Power Plant for some time. American K. A. T. Corp.

21 **Bulletin on Corrosion** — "Corrosion of Plant Equipment by Steam and Water" by Dr. R. C. Ulmer, is a folder reprinted from three issues of Power Plant Engineering. The story gives a general theory of corrosion that occurs in power plants and particularly in boilers; it shows typical examples of corrosion and cavitation and gives the reasons for them. The last article in the folder describes the corrosion of steam lines, superheater and condensate lines and gives suggestions for prevention of corrosion. E. F. Drew & Co., Inc.

22 **Protective Coatings Bulletin**—Details and uses of this new plastic protective coating that waterproofs and vapor seals are given in this four-page, two-color pamphlet. The bulletin lists the product's special adaptability for use on above-ground tanks, gas holders, railings, fire escapes, storage tanks and towers, cooling towers, etc. and also tells about its ability to damp-proof wall surfaces. Details also are given about the product's quick drying, fire retarding qualities and its ability to withstand temperature extremes. Wailes-Dove-Hermiston Corp.

23 **Water Conditioning News**—The latest quarterly issue of this company's publication, "Dearborn News," has just been called to our attention. The bulletin covers latest developments in the water treating field and also tells about rust prevention. It is well illustrated. The bulletin, issued quarterly, will be sent regularly to all who are interested. Dearborn Chemical Co.

24 **Water Treatment Handbook**—Titled, "Fundamentals of Water Treatment and Control for Steam Generating Equipment," this 64 page handbook covers basic theories involved in the treatment of feedwater and also discusses in detail the company's method of water treatment. The first section of the booklet starts out with the basic elements of water treatment, discusses the nature of water impurities and their effects on boilers. Tables published included typical contaminations found in rain water, typical analyses for hardness and dissolved solids, solids deposited by rainfall, etc. The effect of contaminated water such as corrosion, scale formation, foaming and embrittlement are covered. The booklet then discusses scale formation and its control, the theory of phosphates and their use in boiler water treatment. The theory of colloids and their use in boiler water treatment, corrosion and its control, priming, foaming and their control, and oil in boilers and its control. This section is replete with tabular material and illustrations. Section 2 is completely devoted to the company's method of boiler water treatment and covers the use of test kits, chemical analyses charts and methods of testing. Magnus Chemical Co., Inc.

PUMPS

25 **Centrifugal Pumps**—Bulletin 225-Revised is a 4 page booklet describing the company's single stage, double suction centrifugal pumps Type DB and DBM. Specifications of both of these units are covered and sectional views with various parts labeled are presented in the inner spread. Tables of dimensions and drawings plus a rating table in U. S. Gallons Per Minute at various heads from 20 to 170 ft are given on the back page of the folder. Warren Steam Pump Co., Inc.

26 **Rotary and Power Pumps**—These two bulletins—W-487-B10B and W-412-B30A—describe this company's heavy duty rotary pumps and horizontal duplex plunger pumps respectively. Both the bulletins have six pages and present cut-away views of the units. Tables of performance and specifications and sizes and ratings data are given. The first of these bulletins also gives a chart of performance. Worthington Pump & Machinery Corp.

27 **Pumps Data Book**—The 180 pages in this paper-bound Catalog No. G-47 are filled with complete information on all the pumps and water systems in the company's line. Among the types covered are centrifugal pumps, sump, deep well, rotary, oscillating, etc. Besides complete descriptions of the units there are full page tables of performance data. Cut-away illustrations show construction and operation of the units. Engineering information, telegraph ciphers and indexes are given in the last 15 pages of the book. The Deming Co.

LUBRICATION

28 **Specialized Industrial Lubricants**—Water repellent qualities of these lubricants combined with their high film strength at low viscosity are shown, in this booklet, to be two outstanding reasons for the successful application of these lubricants to all types of industrial machinery. Examples of the use of various of these specialized lubricants for such equipment as hydraulic systems, for open gears, enclosed gears, flexible couplings, for wire rope, worm drives, etc., are presented in brief form. Two pages of descriptions which show how the company's "know-how" has solved many an industrial problem is another feature of the bulletin. The Brooks Oil Co.

PACKING

29 **Packings Catalog**—Describing and illustrating the complete line of the company's packings is the purpose of this recently-issued 16-page condensed catalog. Many tables of weights and sizes are included in the booklet and service recommendations are given for each type of packing. An exceptionally useful section of the booklet is a recommendation chart showing the style numbers of packings recommended for practically every type of service. Asbestos Packing & Textile Div., Raybestos-Manhattan, Inc.

30 **Packing**—Three catalog sheets describing stainless steel packing, air cushioned packing and packing for oil refinery service have just been issued. Each of the folders pictures the packing and besides giving a brief description of its construction it lists the various uses for which it is recommended and gives tables of sizes and weights. The Allpax Co.

VALVES

31 **Safety Valves Manual**—Bulletin 108-SV contains 44 pages and gives complete specifications of this company's line of nozzle safety valves. The major portion of the booklet is filled with tables of dimensions, prices and other necessary information for specifying. An outline of safety valve requirements abstracted from the ASME Power Boiler Code is given and tables of pressure and temperature limits are given. Other engineering information includes tables of saturated steam capacities, superheated steam correction factors, and charts. Crosby Steam Gage & Valve Co.

32 **Valves, Fittings, Manifolds**—Catalog R2 is a 20-page bulletin which describes and illustrates globe valves, line valves, charging, purging or drain valves, check valves, liquid indicators, valve manifolds, refrigerant cylinder valves, compressor valve dehydrators, filters, and other items of a similar nature. Each piece of equipment is accompanied by tables giving pertinent data, list prices, weights and code words. Many types of fittings are included in the booklet. Superior Valve & Fittings Co.

33 **Valves Bulletin**—Cast globe and steel angle valves are described in Form 357,, titled "For Positive Control," issued recently. Besides giving a complete description of the valves the bulletin presents an excellent cut-away drawing which depicts features of construction. Tables of materials specifications, service recommendations and list prices are given on the last page of the folder. The Ohio Injector Co.

HEATERS

34 **Gas Fired Unit Heaters**—Bulletin JS3-25M-124 is a 12 page catalog which covers all the features of this company's gas fired unit heaters. Description of the constructional advantages of the unit and cycles of operation of 4 different types of heaters are described in the front part of the booklet. Sectional views show the assembled construction while photographs of detailed parts, accompanied by descriptions, point out other features. Tables of size ranges and capacities are given in the back portion of the booklet. Surface Combustion Corp.

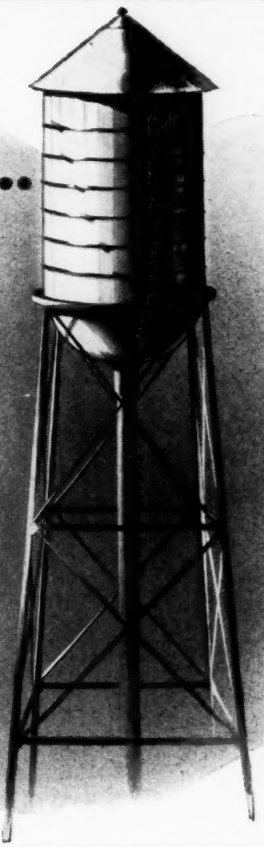
35 **Direct-Fire Unit Heaters**—Bulletin 516 contains 12 pages and completely describes a line of direct fired, oil or gas burning unit heaters. Efficiency of the units' design, and distribution of heat are stressed and the bulletin points out in considerable detail the advantages of "counter flow" combustion. The stainless steel combustion chamber also is stressed. 18 points of construction are described in detail. Drawings show ease of installation and manner of deciding location in buildings. Tables of capacity and dimension are given and complete and detailed list of specifications is printed. Dravo Corp.

36 **Electric Unit Heaters**—Bulletin 45-U covers electric unit heaters and their applications. Complete and detailed descriptions of the various parts of the heaters are given and directions on how

(*Continued on page 164*)

CAN YOU evaporate 1,000,000 lbs. of water...

—and get only 1 lb. of boiler scale?



Amberlite Softened Water ends boiler scale problems

Less than 1 pound of boiler scale formed by 1,000,000 pounds of steam! That's cutting down boiler scale to a minimum.

With the AMBERLITE Ion Exchange Resins, not only can you *soften* water for plant process requirements as well as for boiler feed, but you can reduce alkalinity and total dissolved solids; regulate make-up quality; produce deionized water comparable in quality to single distilled. All with a minimum of equipment, space and maintenance!

In the production of a water of uniformly high quality . . . in many special chemical processes too . . . you'll find the AMBERLITES effective, economical, flexible in operation. Our technical staff will be glad to discuss potential applications.

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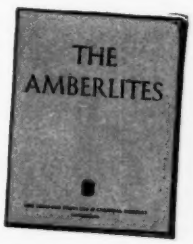

For an outline of applications in which the time-tested AMBERLITES *have convincingly demonstrated their value—and of others in which they offer interesting potentialities—write for a copy of* "THE AMBERLITES." *Address The Resinous Products & Chemical Company, Dept. PP-4, Washington Square, Philadelphia 5, Pa.*

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STANDARD ENGINEERS NOTEBOOK

CALOL RPM

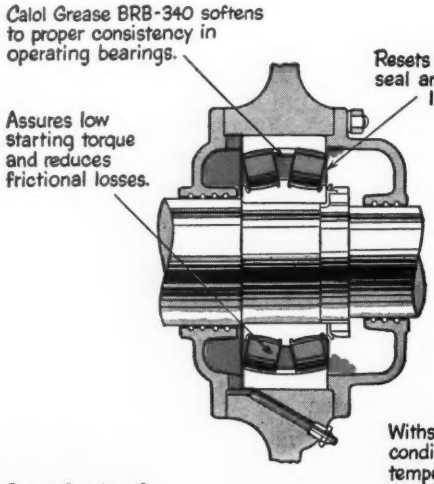
Anti-friction-bearing grease cuts frictional loss

Ball, and roller bearings in severe conditions of speed and temperature will start easier and operate with minimum running friction if they are lubricated with Calol Grease BRB-340.

This special grease is soft, smooth and has a fibrous texture. At high shear rates, it softens around balls or rollers to give complete coverage of all moving parts. However, because of its peculiar resetting ability, grease swept aside by balls or rollers stays hard enough to form a leak-preventing seal.

Calol Grease BRB-340 contains an unusual amount of high-quality oil stock which provides outstanding lubrication. Bleeding of this high oil content is eliminated by a special milling process.

In a bearing operating 10,000 rpm at 200°F. for 528 hours, Calol Grease BRB-340 showed no separation. The bearing was in good condition at the end of the test.

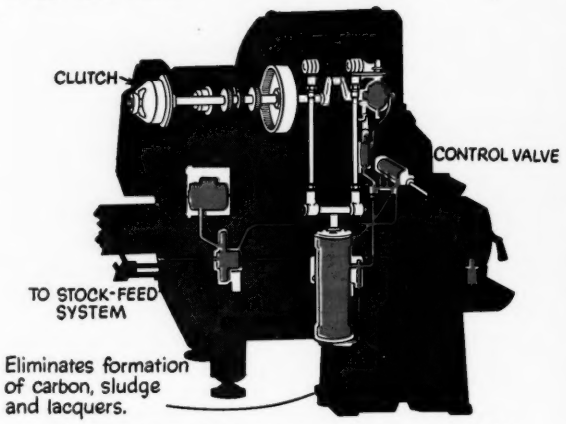

Calol Grease BRB-340 softens to proper consistency in operating bearings.
Resets at edges, forms seal and minimizes leakage.
Assures low starting torque and reduces frictional losses.
Withstands severe conditions of temperature and speed. Non-corrosive to metal.

Roller Bearing for Large Electric Motor.

This drawing prepared with cooperation of SKF Industries, Inc.

Calol O-C Turbine Oil is highly refined — almost water white.

Contains both corrosion and oxidation inhibitors.



Hydraulic Saw-Feed System on Metal-Cutting Saw.

Inhibited oil stops hydraulic system clogging

The formation of rust, gum and lacquer on cylinders, pistons and valves in hydraulic systems on machine tools may be eliminated by specifying Calol O-C Turbine Oil as the hydraulic medium.

This specially made oil contains both corrosion and oxidation inhibitors. Its resistance to deterioration from oxidation is so great that it is rarely necessary to replace original charges in hydraulic units when contaminants are properly excluded—only oil actually lost need be replaced.

Calol O-C Turbine Oil is also widely used in steam turbines by operators who require the finest turbine oil available. It assures protection against rust in initial operation as well as throughout the life of the oil-charge.

Calol O-C Turbine Oil will withstand high operating temperatures and pressures, and is highly moisture-resistant. Comes in four viscosity grades: 9, 11, 15 and 19.

Trademarks, "Calol," "RPM," Reg. U. S. Pat. Off.

For additional information and the name of your nearest Distributor, write Standard of California, 225 Bush Street, San Francisco 20, Calif.; The California Oil Company, 30 Rockefeller Plaza, New York 20, N. Y.; The California Company, 17th and Stout Streets, Denver 1, Colo.; Standard Oil Company of Texas, El Paso, Texas.

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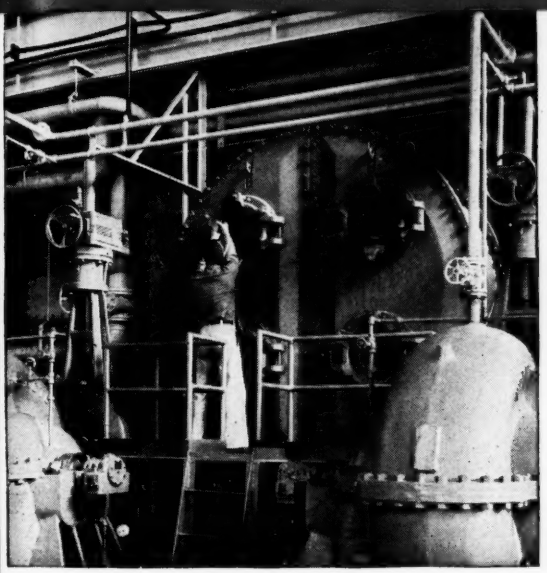

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—with Dowell chemical cleaning

Leading engineers, responsible for power plant efficiency, have found in Dowell's *chemical* cleaning service a modern method for *reducing costs*. They know that more efficient operation of boilers, condensers and other heat-exchange equipment is achieved easily after chemical scale removal service. Power plant operators can see for themselves how safe, how rapid, how effective this tested process really is—when applied by *specialists* in chemical cleaning.

Dowell engineers fill the equipment with liquid solvents designed to dissolve and disintegrate the accumulated scale and sludge. They are experienced in practical methods, know which solvents to use, and bring with them adequate equipment—special truck-mounted tanks, pumps, mixers, heaters—for complete control of each stage in the successful job. To save dismantling and down time—to reduce operating costs—call Dowell. Ask for "More Power To America's Industry!" —free color booklet showing how Dowell service engineers use chemicals to clean steam generating equipment, heat-exchangers, water lines, water wells, cooling jackets and many other types of equipment.

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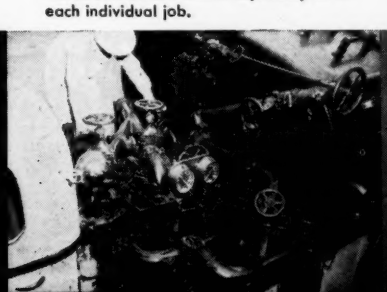
Dowell's industrial engineers are thoroughly experienced in successful chemical cleaning. They are supported by the full research and technical resources of Dowell's own laboratories.

Dowell's field equipment includes the most modern types of scientific devices. Solvents for Dowell chemical scale removal service are mixed especially to fit each individual job.

FREE SHOWING! *New 18-minute sound slide film illustrating the possibilities of Dowell Chemical Scale Removal Service. To arrange a special showing call or write Dowell.*



DOWELL

FOR INDUSTRIAL CHEMICAL SERVICE

NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Illinois.

A Gage Case

Helicoid Gage Division of American Chain & Cable Co. announces a newly developed gage case. It is made of a high compression molded aluminum alloy and is called Acaloy case. The surface of the case is treated by a patented process to prevent corrosion, and it is claimed that the case

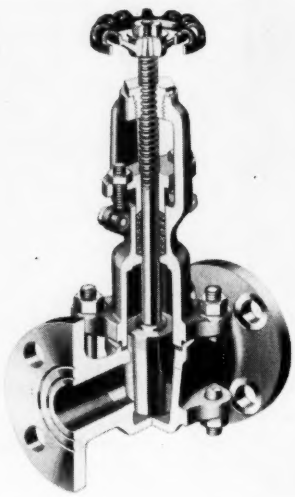
will withstand 1500 hr salt spray test. Over this treated surface there is a black baked-on finish. The case is claimed to be weather-proof since it is provided with a synthetic rubber sealing gasket and a stainless steel snap ring. This new case is designed to accommodate safety blowout discs, which are supplied when required.

B Plug Gate Valves

Crane Co. announces a new line of corrosion-resistant plug gate valves which are unique in that they combine the advantages of the two most important basic types of valves. The new design provides straight-through flow in the wide-open position as do conventional gate valves, yet it is as suitable for throttling service as conventional globe valves.

Extensive tests conducted in the Crane Research Laboratories and in the field have established the following advantages for the plug gate valves: (1) They offer very little resistance to flow in the wide-open position, having a maximum discharge equal to that of a wedge gate valve and about twice that of a globe valve; (2) The design permits very close throttling at both high and low velocities; (3) Resistance to cutting action of the fluid when in a throttled position is equal to that of conventional plug type globe valves; (4) The valve is not subject to sticking in the closed position, even though it be closed while hot and opened when cold; (5) There is no tendency to galling, which is so prevalent in alloy wedge gate valves, especially in the small sizes.

Of outside-screw-and-yoke design, the



new plug gate valves have bolted bonnet joints and are available with either screwed or flanged ends in sizes from ½ to 2 in. They are regularly furnished in either 18-8 Mo or Monel metal. For particular corrosive conditions they can also be made in various other alloys to customer's specifications.

C High-Speed Indicator

Where a large number of thermocouple temperatures must be logged in a short time, the Speedomax Indicator is the answer to the problem, says the manufacturer, Leeds & Northrup Co. To rear a temperature, the operator merely

flips a key switch marked for the desired thermocouple; the instrument's drum scale spins, to stop quickly and surely at the correct temperature. When logging temperatures, the limiting factor is the speed with which the operator can write down his readings.

In addition to speed, the indicator has high sensitivity and accuracy, even for low temperatures and short ranges. Wide markings make its scale easy to read.

Switching arrangements can be supplied to meet the needs of practically any application. A single instrument easily handles more than 100 thermocouples. Key switches can be color-coded for convenience in identifying points.

Heart of the indicator's high-speed balancing mechanism is an amplifier unit, which uses standard, easily-bought vacuum tubes. The indicator uses the same case as strip-chart Micromax and Speedomax Recorders, and fits into standard panel cutouts for these instruments. All the more commonly used ranges for industrial thermocouples can be supplied.

D Vacuum Deaerater

For some industrial and process services and in many municipal water supply systems, it is desired to remove oxygen and other dissolved gases from cold water in order to prevent corrosion at low temperatures.

Liquid Conditioning Corp. announces its development of the Liquon Vacuum Deaerator for this purpose. The unit consists essentially of a chamber in which the water is broken up into thin sprays and films to permit the release of the dissolved gases from the exposed water surfaces, and a steam ejector or vacuum pump to maintain the necessary vacuum corre-

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JULY, 1947

POWER PLANT ENGINEERING

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Fig. 1430
Iron Body Gate

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Speeded-up production has taken its toll of plant equipment. Break-downs and unexpected failures are more numerous.

A thorough check-up now will pay dividends. And don't overlook your steam, water, and air lines. A sudden valve failure might mean loss of valuable power and production.

But should valve trouble occur, you can get help . . . quickly . . . from your near-by Lunkenheimer Distributor. Long established in the community, he has thoroughly experienced personnel and adequate stocks . . . all the facilities and "know-how" for solving your valve problems.

Whether it's an emergency call, routine repair and maintenance service, or a new installation to make, phone your Lunkenheimer Distributor for fast, dependable service.

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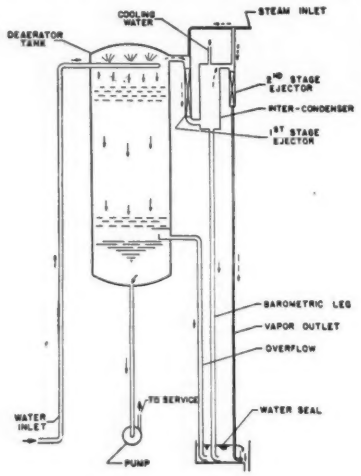
BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.;
BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

sponding to the boiling point of the water at its comparatively low temperature.

In the gas-separating chamber, the water is first sprayed at the top, and then trickles down in thin films over a fill of staggered non-corrodible trays or slats. The deaerator shell is long to provide the considerable height of column which is necessary for the low attainment of equilibrium at the low temperature.

Where steam is available, the required vacuum is created by a two stage ejector



with an inter-condenser between. The condenser is provided to reduce the amount of gas to be handled by the second stage of the ejector, thus saving steam. Motor-driven vacuum pumps are used where steam is not available.

Since the dissolved oxygen in water causes corrosion which weakens and destroys iron or steel pipe lines, and also causes rust deposits which rapidly clog pipe lines and make the water unsuitable for many purposes, the Liquon Vacuum Deaerator is of great value. Installations can quickly repay their cost by alone preventing increased pumping expense due to dust-clogged pipe lines.

E Natural Draft Cooling Tower To meet the increasing demand for a more flexible spray type natural draft cooling tower, the Marley Co., Inc. is offering the new Series 200 tower. It may be purchased in various sizes, added to at any time as expansion is required and used for open or closed cooling systems. The new Series 200 incorporates several new features developed during extensive field tests. Among its features: Standardized for volume production and economical construction; Designed in standard bays enabling an increase in tower size if requirements increase; Standard atmospheric sections easily installed at any time for closed system cooling; Rough lumber utilizing full dimension strength and low cost; Designed to withstand 100 mph wind. Earthquake design or 112 mph design at small additional cost; Heavy select heartwood lumber used throughout with galvanized bolts and special hardware at critical joints; Capacity of 65 to 1580 gal or more of water per minute; Marley spray nozzles for perfect spray pattern; Prefabricated and shipped "knocked down" with every member piece marked.

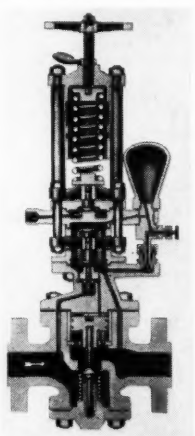
Complete erection, operation and maintenance instructions furnished with tower.

F Rayon Conveyor Belt Another development in the industrial rubber goods field was announced by Raybestos-Manhattan, Inc., Manhattan Rubber Division. It is a conveyor belt with rayon cord plies as a strength member.

This new belt is designed to meet the needs of mechanized coal and metal mines, quarries and limestone plants for a belt of higher tensile strength for increasing heavy-duty, long-lift conditions. Because of extensive mechanization in mines and quarries in recent years the trend has been toward longer belts, higher lifts and heavier loads.

Advantages claimed for this new belt are: troughs easily, has virtue of fiber resilience, can utilize conventional type idlers and pulleys, can be field-spliced with conventional methods, permits construction modifications to suit varying service conditions.

G Pump Governor To improve pump performance and reduce governor maintenance through elimination of stuffing box and rubber diaphragms, Leslie Co. has developed a line of pump governors, specially designed for high accuracy of control and to resist the ravages of wear and erosion.

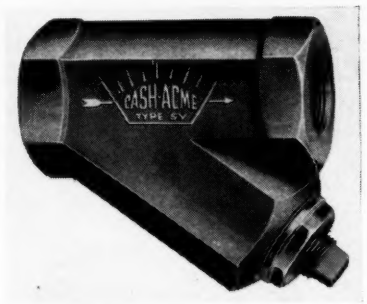


Hard surfaced seat rings, 800 Brinell hardened stainless steel main valve and 500 Brinell cylinder liner reduce wear where it is usually felt the most. The hard seating surface is applied as a welded section to seat rings of bronze governors and to the main body of steel governors. Combined with the 800 Brinell main valve it provides a long life combination.

Other design features include instrument accuracy of regulation, wide spring range which permits settings without change of spring or diaphragm, single seated valve, no packing or stuffing boxes, complete interchangeability of replacement parts without removal of the body from the line.

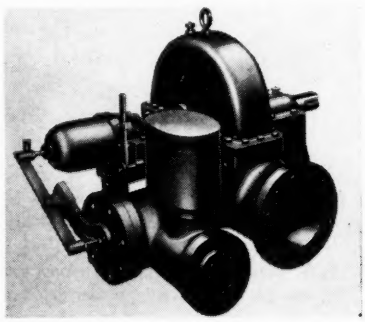
Available in sizes from ½ in. to 4 in. for inlet pressures from 40 to 600 psi at temperatures to 750 F.

H New Strainer It is a "Y" type strainer and is available in pipe sizes from 1 in. through and including 2 in. It is available in either cadmium plated rust resisting cast iron or all bronze con-



struction. These strainers are built around 250-lb standards for cast iron, and are suitable for 400-lb service when furnished with bronze body. A. W. Cash Valve Mfg. Corp. announces this strainer.

J Mechanical Drive Turbines Elliott Co. is announcing a new improved YR line of mechanical drive turbines. This line of turbines continues all the advanced features of the Elliott Y line of turbines, thousands of which are now in operation in practically every industry in the country.



The new YR turbines also incorporate increased capacities (up to 2000 hp), higher allowable steam pressures and temperatures, higher allowable back pressures (through 250 psig), higher operating speeds (through 6000 rpm), and in general greater flexibility. Full advantage has been taken of new materials and latest construction techniques. The turbines have been made suitable for installation outdoors by sealing the bearings and completely enclosing the governing parts. Maintenance costs have been reduced by standardizing parts so that they can be used on two or more frames and by simplifying parts, such as main bearings, to reduce replacement costs to a minimum.

K Allspeed Selector Two new higher horsepower models have been added to Worthington's line of Allspeed Selectors. Designated as models D and E, these supplement the lighter models A and C, and are designed for instantaneous, stepless precision control on heavy industrial machinery. Model D delivers 2-5 horsepower, has a speed range from 360 to 2880 rpm, using a 1725 rpm input—

All piping equipment . . . All pre-fabrication . . . on One Order to CRANE

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OUTSTANDING QUALITY in every item—assuring uniform dependability and durability in every part of piping systems.

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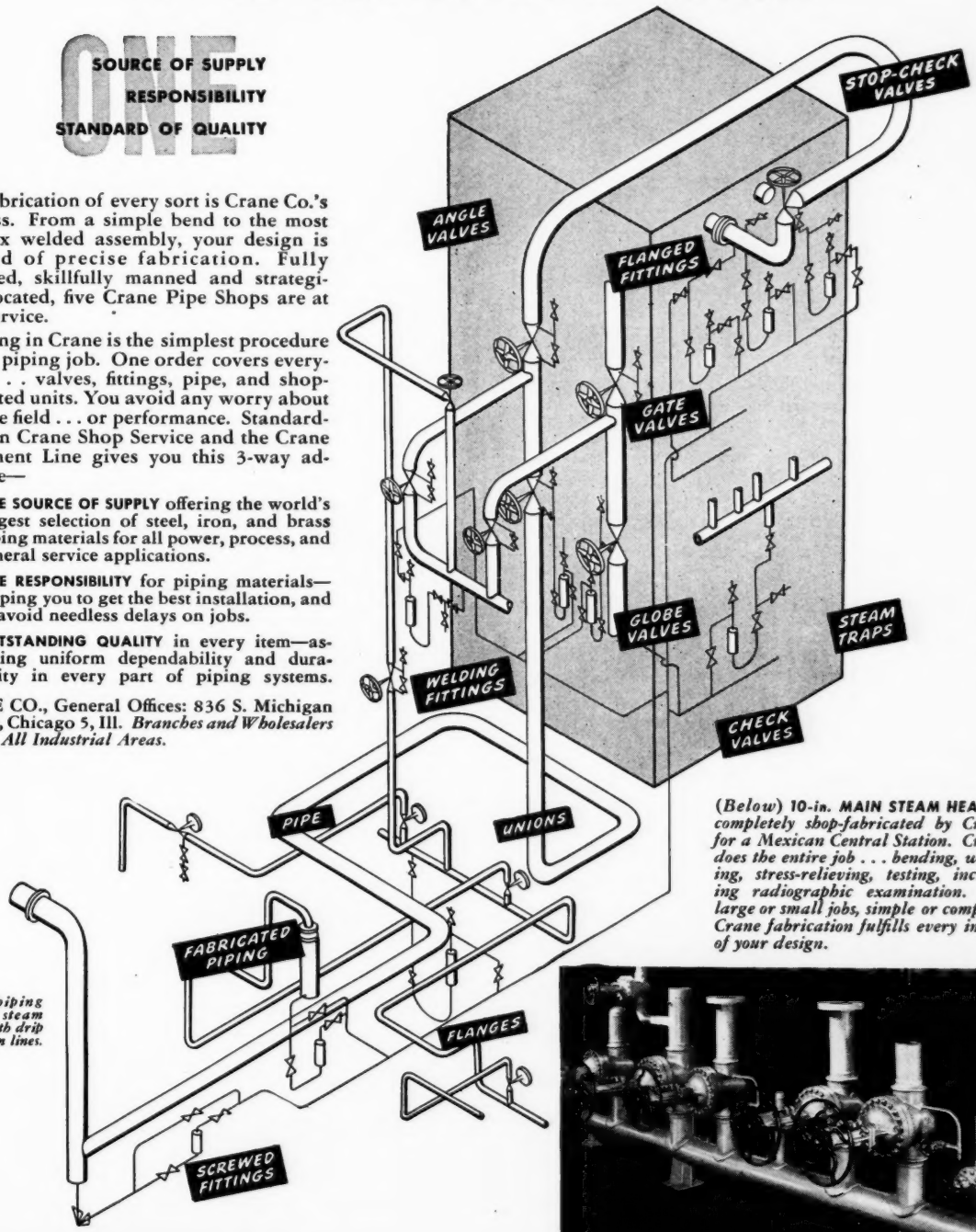
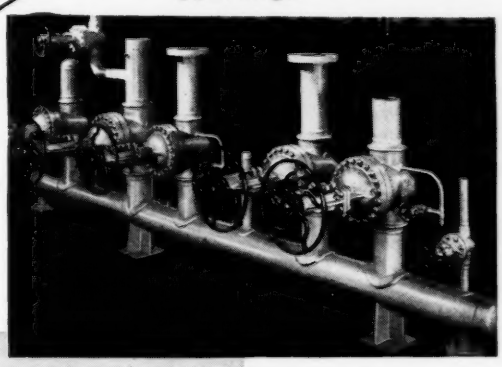


Boiler piping showing steam mains with drip and drain lines.

(Below) **10-in. MAIN STEAM HEADER** *completely shop-fabricated by Crane for a Mexican Central Station. Crane does the entire job . . . bending, welding, stress-relieving, testing, including radiographic examination. On large or small jobs, simple or complex, Crane fabrication fulfills every intent of your design.*



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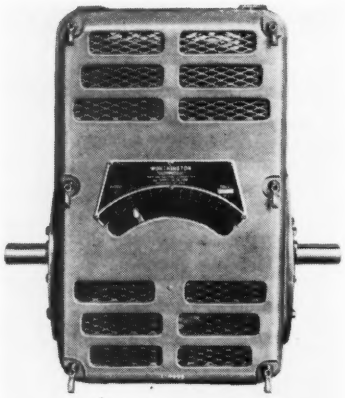


a ratio of 8 to 1. Model E delivers 2.7 to 7.5 hp, and a speed range of 410 to 2460 rpm using a 1725 rpm input—has a ratio of 6 to 1.

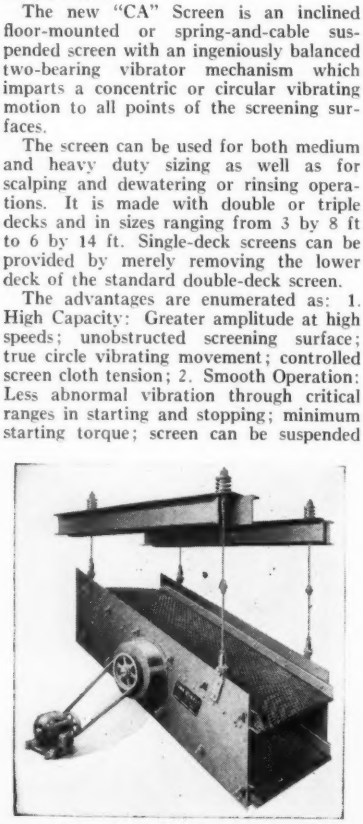
These two new drives incorporate the same tandem belt design as employed in the popular lower hp Allspeed selectors, as well as the other exclusive features including automatic and positive belt tensioning, compactness, universal adaptability and easy maintenance.

L Concentric-Action Screen A new vibrating screen, to be known as the "CA" Concentric-Action Screen, is announced by Link-Belt Co. as now being available, to meet a constantly-growing demand for economical and effective sizing of a large variety of materials.

The new "CA" Screen is an inclined floor-mounted or spring-and-cable suspended screen with an ingeniously balanced two-bearing vibrator mechanism which imparts a concentric or circular vibrating motion to all points of the screening surfaces.

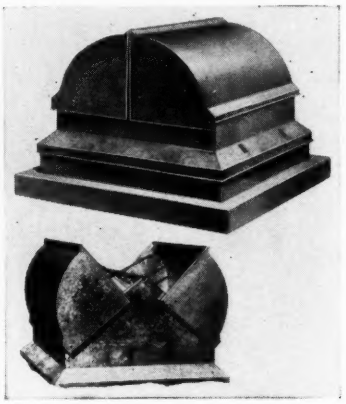
The screen can be used for both medium and heavy duty sizing as well as for scalping and dewatering or rinsing operations. It is made with double or triple decks and in sizes ranging from 3 by 8 ft to 6 by 14 ft. Single-deck screens can be provided by merely removing the lower deck of the standard double-deck screen.

The advantages are enumerated as: 1. High Capacity: Greater amplitude at high speeds; unobstructed screening surface; true circle vibrating movement; controlled screen cloth tension; 2. Smooth Operation: Less abnormal vibration through critical ranges in starting and stopping; minimum starting torque; screen can be suspended



by cables or mounted on floor; 3. Low Maintenance: Easily serviced and inspected.

M Powered Roof Ventilator Announced by The Swartwout Co. is an addition to its line of industrial roof ventilating equipment—a "straight-through" type of powered ventilator. Made in five sizes with a wide range of capacities, the new product, named Ject-O-Valve, uses a propeller type fan to exhaust heat, smoke, fumes, etc. through a divided top which opens and closes automatically. The ventilator is weather-tight at all times.

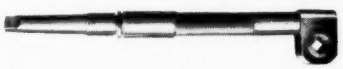


N Boiler Water Column And Controller Magnetrol, Inc. has just announced a new unit which combines both water column and multi - stage boiler water level controller in a single unit. This combination unit offers the advantages of (1) lower first cost, (2) easier installation, (3) space saving, (4) more reliability, and (5) reduction in boiler maintenance because it requires only one blow-down instead of two.

This new unit which combines all the features of the simple magnetic operating principle found in the standard multi-stage Magnetrol is made in two models: Model W-126 for pressures up to 125 psi and Model W-251 for pressures up to 250 psi.

O Boiler Tube Expander-Driver Since it is difficult to reach many spots in present day boilers with tube expanders driven by portable drills, flexible shafts, or similar driving units, Invincible Tool Co. has developed an angle tool attachment known as the Invincible Boiler Tube Expander-Driver. This new tool, states the manufacturer, provides the link between the tube expander and the driving unit, making it easy to get at "hard-to-reach" spots.

These Expander-Drivers work in right- or left-hand corners. They are made in two standard sizes with ¾ in. and ½ in. square driving chuck. A special ball thrust take up takes the thrust both forward and reverse, making for smooth, free-running operation. All thrust action is taken direct-



ly on these bearings, allowing instant reversal of driving direction. These tools are ruggedly built for heavy-duty service, can be used to run on or off nuts, studs and bolts in tight spaces, and are obtainable in square or hexagon spindles and square, hexagon or Morse Taper shanks. Special models can be designed to meet individual requirements.

P Aluminum Solder Independent laboratory tests on the metallic and electrical properties of Prolyt, the new aluminum solder from Switzerland which is being manufactured and distributed exclusively in this country by the Aluminum Solder Corp. have shown that this bonding material can spell a new era in the use of aluminum, according to the corporation.

The investigation, conducted by the New York Testing Laboratories, showed that Prolyt, which was used to solder aluminum to aluminum without a flux or flux substitute, resisted shearing after a 250 hr salt spray corrosion test, even though the aluminum base metal itself broke.

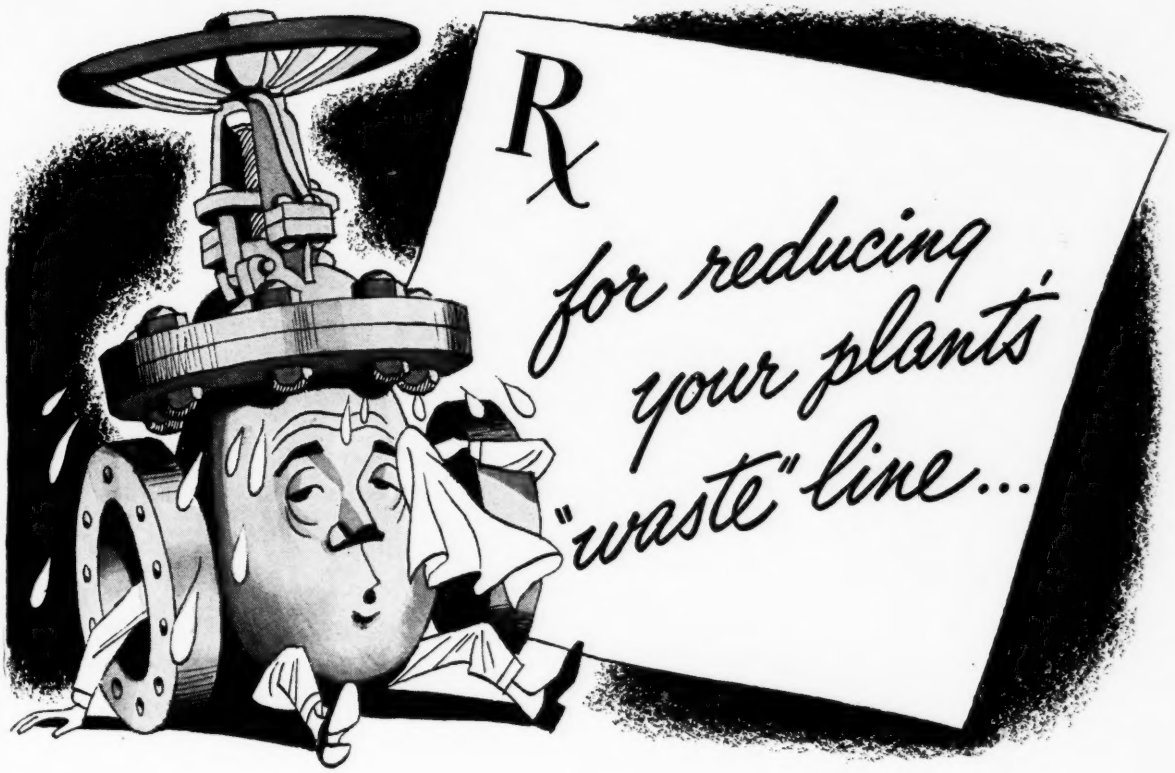
Vibration tests conducted on one-quarter inch and three-eighths inch stranded aluminum cable soldered to standard copper lugs showed the toughness of Prolyt. Although the one-quarter inch cable broke after 44,000 cycles over a 0.040 in. amplitude at a frequency of 2450 cps and the three-eighths inch cable broke under similar conditions after 1,487,000 cycles, at no time during the tests did the solder itself fail.

Q Chain Hoist One development in hoist equipment is revealed in an announcement by the Chisholm-Moore Hoist Corp., of a line of high speed hand operated hoists that are described as 96 per cent mechanically efficient. High efficiency, however, is but one of a large number of improvements said to be incorporated in the new hoists.

Through the use of steel and aluminum alloys, the weight of the hoists has been reduced to a point where they are nearly 45 per cent lighter than standard hoists of comparable capacity. This makes the hoist far easier and safer to handle and install. Along with weight saving, strength and durability have been increased while all excess bulk has been eliminated resulting in the most compact hoist ever constructed.

A big reduction in the number of component parts is another notable feature of the hoist. All rotating parts are fitted with precision ball bearings that have double sealed-in lifetime lubrication. Fewer parts, precision anti-friction bearings and sealed-in lubrication increase lifting speed, reduce operator fatigue and practically eliminate servicing costs.

Noteworthy improvements have also been made in the lift wheel, load chain guide, gearing and load brake. Particular attention was given to reducing to a minimum the pull required by the operator to



B-H No. 1 Insulating Cement makes it easy to keep BTU's where you want them

Here's the fast, efficient way to prevent fuel waste through the surface of valves, fittings and other irregular surfaces.

Fast—because you simply add water, mix and apply. B-H No. 1 sticks instantly—won't slide off bottom surfaces or roll up behind the trowel.

Efficient—because it's compounded of *Black* Rockwool—insulates up to 1800°F. For example, a 3-inch application reduces 800°F. surface temperature to 150°F.

Other advantages: B-H No. 1 doesn't crack or peel. A special rust inhibitor safeguards against corrosion, assures a permanent bond. Reclaimable up to 1200°F.

Check over the places in your plant where heat loss can be prevented. Then send for full information and a working sample of B-H No. 1 Cement.

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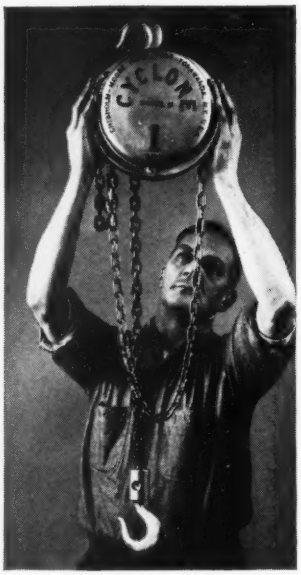
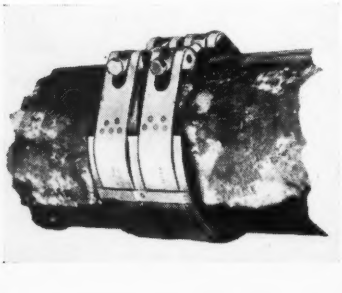


lower the load. The result is that a surprisingly light pull is sufficient to unlock the brake and lower the load. At the same time the lowering load is at all times under perfect control. This feature is exceptionally valuable in spotting or assembly work where smooth, easy and accurate movement is demanded.

Known as the Cyclone Model M, the new high speed hoist is available in four standard capacities: ¼ ton, ½ ton, 1 ton and 2 tons. All models are equipped with "Herc-Alloy" steel chain.

R Liquid Level Gages New Type S, Tank-O-Meter for measuring tank contents of tanks at any remote point regardless whether the tanks are open, vented, under pressure, or under vacuum, have been announced by Uehling Instrument Co. They can be furnished with high or low alarm switches for closing or opening any circuit at any pre-determined high or low levels. Fifty-two standard models for measuring liquid depths ranging from one foot to seventy-five feet. Can be furnished for hand pump or compressed air operation.

S HP Pipe Leak Clamps A new line of high pressure pipe leak clamps, withstanding pressures of 1100 psi on corroded pipe without leaking, is announced by Marman Products Co., Inc.

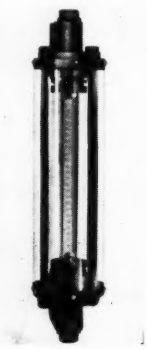


Designed as permanent repair clamps for high pressure pipe leaks of oil, gas, aromatic fuels, water, etc., these stainless steel clamps weigh up to a maximum of only six pounds, and can be installed by one man. Interesting features of these clamps include extreme high strength and corrosion resistance; laminated Hycar rubber pads which compress into corroded area of pipe when under pressure, while resisting the tendency to cold flow; and a stainless steel patch plate, which slides on clamp band, affording the most advantageous positioning of clamp over leak.

These clamps are being produced to fit all sizes of pipe from 2 to 8 in. Larger sizes can be made upon request.

Addition of the high pressure pipe leak clamps to the Patch Master and low pressure types, provides a line which covers every need for quick, permanent pipe leak maintenance. Deliveries can be made in one week from receipt of order.

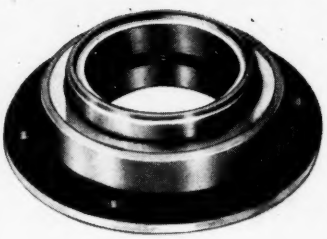
T Vapor Proof Rota-Meter This new vapor-proof Rotameter announced by Schutte & Koerting Co. has a clear plastic tube which encloses the entire frame and metering tube assembly. The protection afforded by this overall covering is two fold in that it prevents damage to the pyrex tube, or packing glands and bolts where the atmosphere is corrosive in character and it also acts as a guard against leakage of fumes where toxic gases are being metered. In the latter case, a vent in the end fitting may be provided for the installation of a small pipe to carry fumes outside the building. In addition, the plastic tube protects the glass tube against breakage and keeps dust, grease and dirt from the external surfaces of tube and packing glands.



U New Carbon Seal Announcement has just been made of a new high speed carbon ring oilseal, which is said to particularly suit those sealing applications where oil lubrication is at a minimum, where the seal runs in a liquid other than grease or oil, or where the shaft speed is greater than that satisfactorily served by a bronze ring altho a good supply of oil is available. It is announced by Gits Bros. Mfg. Co.

These carbon rings, which have been developed especially for shaft seal use, have a low coefficient of friction and self lubricating qualities which make them superior to high lead bearing bronze in those applications where lubrication is poor or where shaft rpm and resulting rubbing speeds are high. Other highly favorable characteristics of carbon are that the material is heat resistant, not subject to warming, chemically inert and corrosion resisting.

The design of this new carbon ring seal can be classed as rather unique. The entire assembly, known as the Gits "DMC" and "DPC" High Speed Carbon Faced Seals, features a sealing principle that completely eliminates wear on the shaft and the need for replacement of grooved shafts.

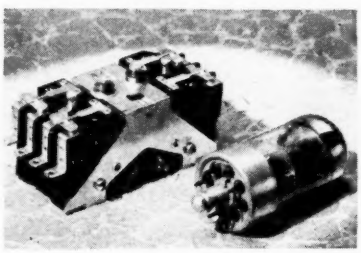


These seals effect a perfect seal against leakage of liquids or gases under pressure or vacuum by means of a radial seal joint made by positive contact between a stationary lapped seal surface built into the seal unit and a rotating lapped seal surface. They do not contact or wear the shaft surface, as does the conventional type oil seal, but transfer the wear to the radial seal joint instead.

This seal is built as a compact unit requiring a minimum amount of space diametrically and axially. In applications where weight is a factor, most of the seal parts have been made of aluminum to reduce unit weight to a minimum. It is stated that these seals can be applied to both horizontal and vertical shaft applications in many ways.

V Latching Relay Sigma Instruments has just released data on a new multicircuit switching relay of the latching type. Believed to be a substantial step forward, the Type 6FZ series relays are designed to eliminate two principal weaknesses.

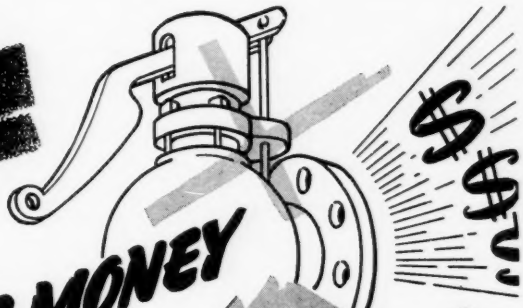
As the entire moving system is dynamically balanced, while operating with detent forces of over 200 inch-grams, an exceptional freedom from the effects of vibration and shock is attained. Mechanical wear, on the other hand, does not lessen, but, if anything, increases the latching stability —resulting in a mechanical life well up into the millions of operations.



Individual switch positions, of which there are eight, each of which may be normally open or normally closed, carry a nominal rating of 5 amp at 110 a-c or 24 v d-c, although actual ratings vary with life requirements and character of load. Contacts may be ganged or arranged in pairs for a maximum of 4 double-break circuits.

W Variable Pitch Pulleys A new line of variable pitch pulleys, suited to vertical as well as horizontal shaft mountings, is now available from the Gerbing Manufacturing Corp. These new products maintain a

3,000 psi 1,000°F



THIS NEW SAFETY VALVE SAVES MONEY ON EVERY POP!

The Foster Type 38-SV Super-Jet Safety Valve for pressures up to 3000 pounds and temperatures up to 1000° F.

Because it reseats as close as 1% below popping pressure, the Foster 38-SV Super-Jet Safety Valve saves steam—saves *money*—on every pop. This new valve blows off only enough steam for safety . . . then reseats positively, without pounding or chatter.

But steam economy is only one advantage of this new safety valve. It is virtually unaffected by changes in temperature—once set under operating conditions, its popping point is constant. It gives full rated nozzle capacity at popping pressure—with negligible accumulation. Full opening is practically instantaneous—reseating is positive, without flutter or rebound even after sustained or successive lifts. And blowdown is adjustable from 8% down to 1% without chatter or pounding because steam cannot accumulate above valve disc.

The Foster 38-SV Safety Valve was especially designed for pressures up to 3000 pounds and temperatures up to 1000° F. In fact, they are now being tested at temperatures considerably above 1000° F. Investigate its many features and advantages by writing for Bulletin 25 today.

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

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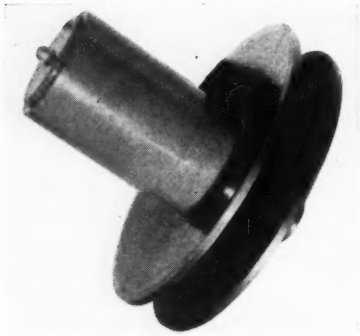


constant centerline and allow use with a V-groove companion sheave.

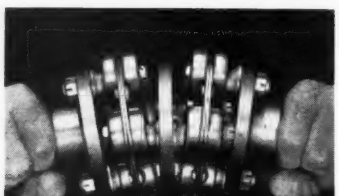
These pulleys are adaptable to standard constant speed motors of one-third to two horsepower at 1750 rpm, giving variable speeds with a 3:1 ratio. In addition to the above, models for both higher and lower horsepower ratings are to be manufactured.

According to the manufacturer, the maximum key area incorporated in the new design results in longer equipment life and quieter operation. Motor bases and belts are supplied with the pulleys which may be installed on new machinery or on equipment already in service.

X Flexible Couplings

Double Morflex couplings (a universal-joint type) are now in full production, according to Morse Chain Co.

Since the Double Morflex is, in effect, two single Morflex couplings with a center plate adapter, the new model has twice the torsional resilience (softness) of the single coupling. Torsional resilience is obtained through the preloaded Neoprene biscuit construction. Acting as a universal drive



connection, the double coupling accommodates offset and angular misalignment of shafts.

The double Morflex permits constant velocity between driving and driven member. With no metal-to-metal contact, Morflex requires no lubrication, is proof against noise and vibration, reduces bearing wear, and is dielectric.

The double coupling is available in 10 sizes, in capacities of 13 to 725 ft lb of torque.

Y Centrifugal Pumps

Designed to meet a wide scope of pumping requirements in diversified industries, a new line of standardized side suction centrifugal pumps is announced by The Deming Company.

The pumps are made in three types, single ball bearing with open type impeller, two ball bearing with open type impeller, and two ball bearing with semi-enclosed impeller. Each of the three types of pumps is made for belt drive and for direct connection to electric motor.

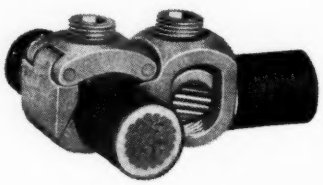
The complete line includes five sizes, ½, ¾, 1, 1½, and 2 in. side suction. Capacities range from 2 to 200 gpm.

Z Hinged Connector

One typical connector of its new XPT line replaces up to 32 different parallel or tee connectors, says the manufacturer, O. Z. Electrical Manufacturing Co.

Available in twenty-five sizes, accommodating over 400 wire combinations ranging from No. 8 to 1,000,000 cm, the XTP will do practically all tap jobs. Further, the wide range of the XTP reduces the number of connector types users need carry in stock.

The one-piece, hinged construction of



this new connector makes for speed and simplicity in installation. It can be permanently attached to the main and left for the tap to be attached later. One end of the connector is simply snapped over the main and tightened, the other has serrated openings to which a tap can be run in any of three directions. Other advantageous construction features are: spring steel lock washers (tin plated) maintain permanent pressure; grip-holding serrations on wire-contact surface for maximum pull out strength; non-rotating pressure plates; highly conductive copper alloy body; extra strength copper alloy hinge and pressure plates.

AA Inspection Mirror

A new inspection mirror, made by Delavan Engineering Co. offers many advantages for numerous service, maintenance and inspection jobs.

A metal mirror, 3⅞ in. in diameter, has a 20-in. aluminum handle with a flexible joint which permits use of the mirror from any angle. Provides easy visibility in otherwise concealed locations.

For added usefulness, the mirror is made of material which will stand considerable heat without discoloration, and has reflecting surfaces on both sides. The handle is made in three sections for convenience in carrying. Additional 8-in. handle sections are available at slight extra cost. Heavy cloth bag furnished to protect reflecting surfaces when mirror is not in use.

BB Space-Conserving Compressor

A motor-driven compressor of entirely new design, offering tremendous space saving possibilities compared with ordinary big scale industrial installations and especially adaptable for use in chemical, process, oil and gas, mining, construction and general manufacturing industries, was announced recently by The Cooper-Bessemer Corp.

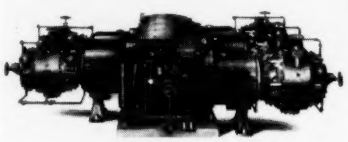
The new compressor has been designated the Type JM. The "JM," available in six sizes and with a great variety of compressor cylinders offers a wide range of volumes and pressures for handling air or gas. It is built with from one to six crank throws and ranges in horsepower from 500 to 2750. The compressor stroke is 14 in. and it operates at a speed of 300 rpm, which is the same as the company's Type GMV compressor. Power for driving it can be taken from a standard sychronous electric motor, an engine, or a turbine. All cast parts are of Meehanite metal, known for its unusual strength and resistance to wear and permitting the use of thin frame sections with low weight ratios.

The one-piece box-like frame is open at the top for admitting the crankshaft and is locked by steel tiebolts and covered by aluminum plates. A sump type base holds the entire lubricating oil supply. The lubricating system, which includes a pressure pump and a built-in filter and cooler, furnishes oil under pressure to all moving parts.

The "JM" has a 10½-in. diameter counterweighted crankshaft, which is supported in babbitt-lined bearings. Both main and connecting rod bearings are of precision type, permitting interchangeability and replacement without scraping or machining. Connecting rod bearing caps are fastened to the rods by four high-strength steel bolts to prevent bearing distortion and each connecting rod has specially designed ribs for added strength.

Crosshead guides, one for each crankthrow, are mounted on the sides of the frame in an alternating arrangement, making the compressor cylinders unusually accessible. The crossheads are adjustable and have babbitt-faced shoes which minimize thrust wear both on the crosshead and guide. A hand hole in the top of each guide provides convenient access to the connectiing rod pin bolt.

Of special importance is the fact that compressor cylinders for the new unit are the same as those used on the Type GMV



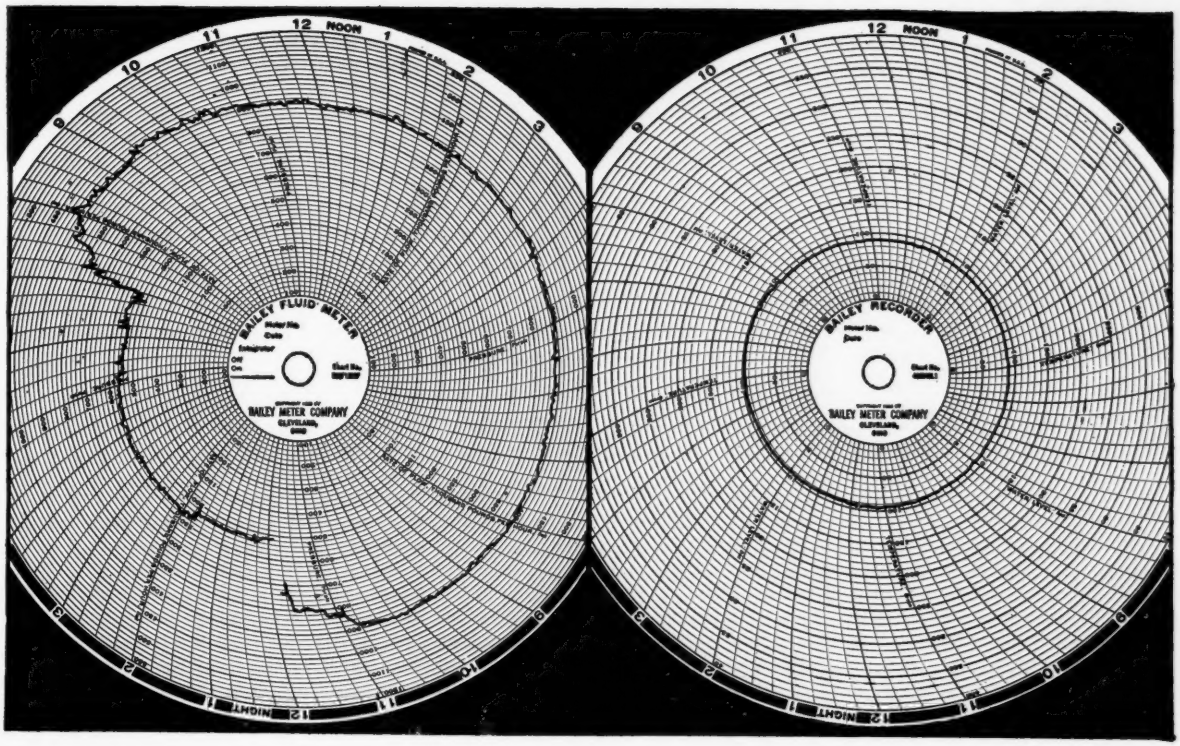
and are interchangeable. Provision can be made for low vacuums or for high pressures, as well as for all intermediate pressures, enabling engineers to recommend precisely the proper size and type of compressor cylinders for any desired volume and pressure within the horsepower limit of the unit. The low and medium pressure compressor bodies are of Meehanite metal while high pressure bodies are of cast or forged steel as required. The cylinder valves are of a standard ring-plate type and are self-cleaning. Valve seats are renewable, and interchangeable from suction to discharge.

Electrical or mechanical unloading by means of compressor suction valve lifters is also available, offering automatic control of flow or pressure. Automatic starting can be provided and compressor cylinders can be automatically unloaded for easy starting. Bearing temperature shutdown, low lubricating oil pressure shutdown and various other controls are available, depending upon the type of installation.

Dimensions of the Type JM compressor range from 11 ft 7 in. to 24 ft 6 in. in lenth, and from 13 ft 9 in. to 24 ft 2½ in. in width.

SOUTHERN STATION REPORTS

level held within plus-or-minus ½-inch



YOU couldn't ask for much closer water level control than is indicated by these charts from a well-known Southern utility station. With a load range of from 200,000 to 430,000 pounds of steam per hour, extreme limits of drum-level variation are no more than plus-or-minus one-half inch.

The steam generator is one of two Combustion Engineering three-drum units in this station. Each has a rated capacity of 425,000 pounds of steam an hour, delivered from the superheater outlet at 860 psi and 835 degrees F. Equally close water level control is obtained on both high-duty units, which are equipped with two-element COPES Flowmatics.

The complete story is told in Bulletin 469, a 16-page performance report on COPES Flowmatic in this and two other stations of the same utility system. Illustrated with plant photographs, sectional views of the boilers and charts, this informative report is yours for the asking. Write for it.

NORTHERN EQUIPMENT COMPANY

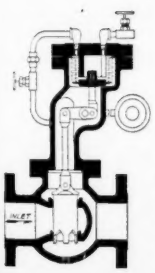
772 GROVE DRIVE, ERIE, PENNSYLVANIA

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS: Canada, England, France

Representatives Everywhere

★ GET CLOSER LEVEL CONTROL WITH COPES FLOWMATIC



DIFFERENTIAL VALVES

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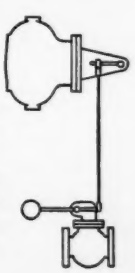

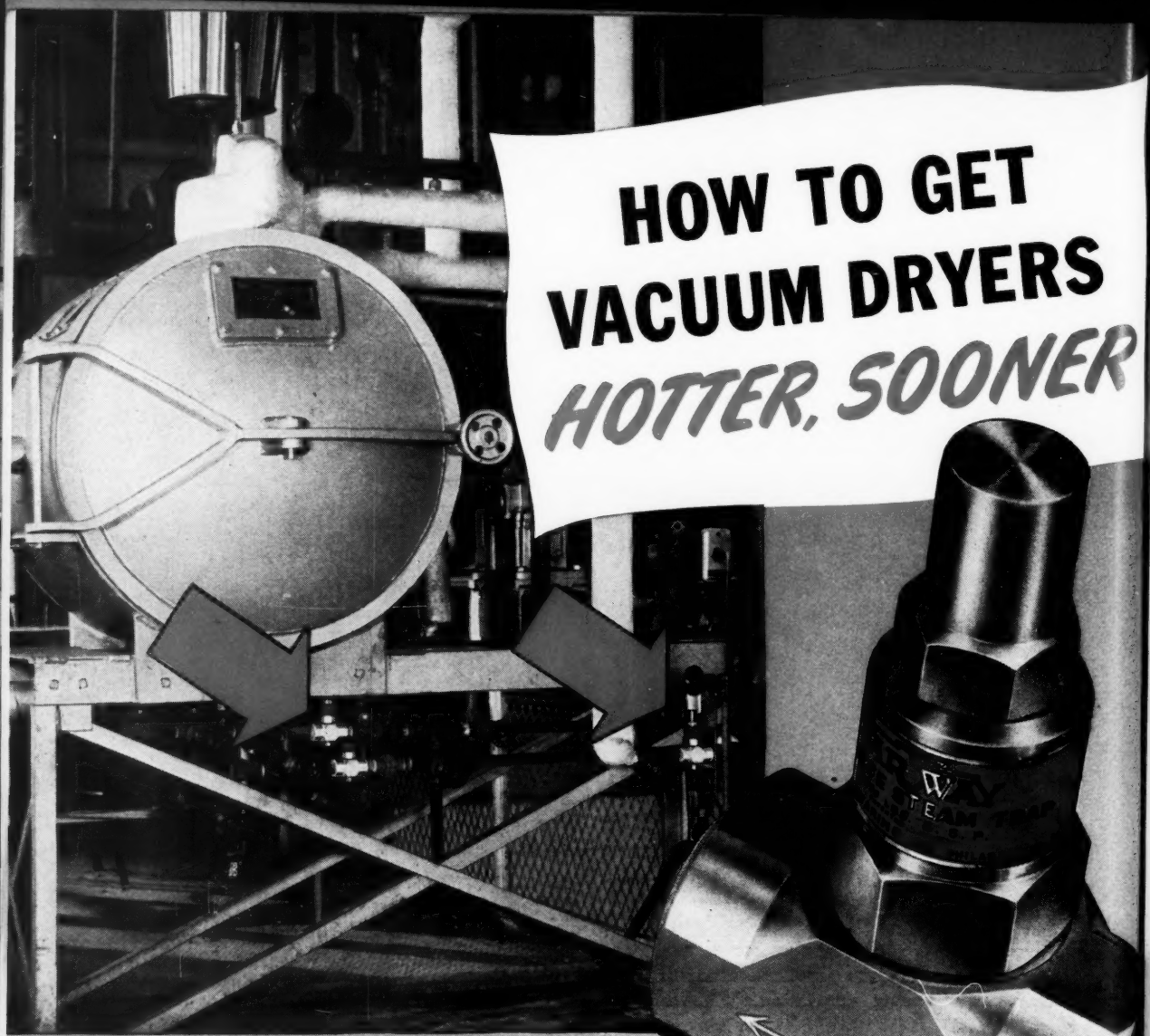

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YARWAY IMPULSE STEAM TRAP

The Third Step

By GENERAL DONALD ARMSTRONG

IT HAS LONG been the accepted role of generals, and perhaps particularly of ex-generals, to refight verbally, for the benefit of their countrymen, the next war in terms of the last one. That kind of thinking, I believe, is as dead today among intelligent military men as it certainly is among intelligent industrial men. The year in which we now stand, 1947, is certain to go down in history as the Year One of a completely new order of industrial progress in this country and in the world.

A New Era

America, above all other countries in the world, has reached the point where the industrial product—the goods for the good life—finally has become supreme.

The United States has risen through the primary subsistence stage of an agricultural economy. It has, in all likelihood, essentially surmounted a secondary technological stage wherein the best brains of the country are devoted, not to production itself, but to the *machinery* of production.

It now is emerging into a vital third era in which the real problem is to produce the fruits of the machine so cheaply and efficiently that they move almost automatically into the hands of the ultimate beneficiary, the consuming citizen of the United States.

Let us step aside for the moment from the lingering problems of the agricultural era and the relatively primitive industrial economy in which we now are operating and look boldly ahead to *The Third Step*.

The Third Step

1. The *Third Step* obviously envisages the making of a greater physical volume of goods than ever has been produced before in the history of the country.

2. It means the production of this vast volume output on an efficiency and cost basis incomparably higher than the general level prevalent today.

3. It calls for a wage system which will enable the producing worker to consume an equitable part of his own output and that of other workers.

4. It demands a system of free government which will make it possible for the worker—consumer to enjoy this flood of goods and for the private enterpriser to provide it.

5. It requires a firm assurance of national security which will guarantee America's right to pioneer this *Third Step* without danger of interference, by *anyone, anywhere* in this pea-sized world of today.

No more than yourselves do I know all the answers to such a breath-taking look into the future. Your brains, my brains, the brains of literally several score of thousands in industry, in government and among the formers of public opinion will go into the ultimate shaping of such a magnificent concept.

But the general direction of the first falterings toward the *Third Step* seem to be obvious enough.

Anything which can be produced by volume techniques in our present relatively primitive industrial society, can be produced better, more cheaply, and more profitably, if the *best practice* at any given point of time, is transformed as rapidly as possible into the *general practice*.

This point will be reached, generally, only when we have a free exchange of information among all interested parties.

There must be a meeting of minds among the producer, the man who sells the goods, and the consumer so that the function each performs comes to its logical conclusion—the satisfaction of the physical wants of the country in such a way that the worker can consume the product; the producer can make a legitimate profit and continue to produce; the seller can provide what the buyer wants, and go on profitably providing it.

There are today many more cases where this common-sense three-way rule is ignored in our economic system than there are cases in which it is observed to the profit of all concerned.

And yet, you know as I do, that a strong country in a staggering world can only be built on such a firm foundation of mutual interest—of, shall we say, "everybody gets his break."

The Machinery

To achieve at least one aspect of this desirable result the machinery already exists. The American Standards Association is a federation of 98 technical, trade, governmental and consumer bodies, and about 2,000 company members which is specifically designed to see that the best industrial practice in any given field becomes as soon as practicable the accepted practice in that field.

It is virtually impossible to put a

(*Continued on page 184*)

After 36 years of service in the U. S. Army, General Donald Armstrong retired in August 1946 and at once joined the staff of American Standards Association to assist Howard Coonley, chairman of its executive committee, in expanding and developing the activities of the Association. General Armstrong's experience in the Army, particularly in the Ordnance Department, gives him an exceptionally fine background for this work.

He began his army career in 1910 as second lieutenant in the Coast Artillery Corps, following his graduation in 1909 from Columbia University with an A.M. degree. Incidentally, he is known as an eminent Latin scholar, served several years as Professorial Lecturer in the Classics Department of George Washington University, also specialized in higher mathematics. In 1918 he served on the staff of the Chief of Artillery, AEF, in France. For five years following the end of World War I, he was in France first with the French Army and then as Assistant Military Attache at the American Embassy at Paris. He studied much at French artillery schools, then in 1923 was transferred to the Ordnance Department.

In 1935 he became Chief of the Maintenance Division in the Office of the Chief of Ordnance and was Executive Officer and Chief of the Chicago Ordnance District from July 1939 to 1942, the year he was promoted to brigadier general. From 1943 to 1944 he served as commanding general of the Ordnance Replacement Training Center at Aberdeen, Maryland. His last service has been as commandant of the Industrial College of the Armed Forces, where his organization of industry advisory committees contributed much to better understanding and co-operation between the industries represented and the armed forces.

He is a member of the AAAS, the New York Historical Society, the American Sociological Society, the Newcomen Society, and a fellow of the Royal Society of Arts. He is also president of the American Military Institute and of the District of Columbia Post, Army Ordnance Association. He has been awarded two Legions of Merit by the War and Navy Departments, respectively, for service in World War II; Columbia University has presented him with a University Medal for Excellence.

The material above is taken from his recent speech before the National Conference of Business Paper Editors at Washington, D.C.

How To Plan Gas Compressor Stations For Long-Range Efficiency

By **BRUNO THIEL,** The Cooper-Bessemer Corporation

NEED FOR gas and gas derivatives in the chemical industry for the production of synthetics, plus the increased life expectancy of oil fields afforded by modern methods of recycling and pressure maintenance, and the trend towards prohibiting wholesale waste of gas from oil wells, are the three principal factors that point toward an even further expansion in gas usage in the near future. In the light of these facts, it seems logical to assume that many additional compressor stations will be built to handle this increased demand. Even though the war-built oil lines are transformed to gas lines, the existing pumping stations built to transport liquids must be rebuilt in order to make them suitable to transport gas.

In the planning of a compressor station, the factors leading to long-range efficiency, stability, and economy must be considered so that the greatest possible benefits can be realized from the initial investment. The following is a generalized outline of the more important considerations in compressor station design and construction, including such specific ideas as are applicable to compressor stations in general.

The first compressor stations consisted of non-condensing steam engines with belt-driven compressors and were followed by direct-driven steam compressors, in which the compressor piston rod was a continuation of the steam engine piston rod, the compressor being mounted at the rear or outboard end of the steam cylinder. The first gas-engine-driven compressors were those in which the gas-engine cylinder replaced the steam cylinder on the steam-engine bed or main frame in those stations having belt-driven compressors. The cheapness and availability of natural gas coupled with the better economy of the gas engine aided in the development of the gas engine. At the beginning of the twentieth century, the compressor stations began to assume somewhat of their present form. From that time onward, great strides have been made both in the design of the gas engines and compressor cylinders, and in the design of the compressor station with its attendant piping and auxiliary equipment.

The design of a compressor station consists of the design of various related parts, a description of which is given under the following headings.

How To Design The Foundations

The base for all compressor foundations should be a mat extending under and beyond all compressor foundations, unless these foundations rest upon solid rock, in which case the foundations should be insulated from the rock by some vibration damping material, such as cork. The mat should be large enough to extend to within a foot or so from the building foundations, but should never extend to or under the building foundations, for this would transmit any engine vibration to the building walls.

In some locations, where the earth on which the mat rests is rather loose, on the order of silt or loose sand, the construction of the mat is made similar to a huge overturned pan with vertical walls extending downward from the lower face of the mat so as to key the mat to the soil and help prevent any lateral movement of the mat. In this type of construction, care must be taken to avoid sharp corners at the junction of the mat and the side and to install the proper reinforcing steel to prevent walls from breaking away from the mat.

If the ground at the station site is insecure, piles should be driven to solid ground, with the outside row of piles sloped with their tops toward the center of the mat. The tops of these piles should be incorporated in the bottom of the mat by means of reinforcing steel. This will prevent, as much as possible, transmission of the engine vibrations to the adjacent structures. All the compressor foundations in any one building should be set on the mat in that building and securely anchored to it. This is the best means of breaking up any horizontal shaking forces, for the shaking forces of one unit will have a

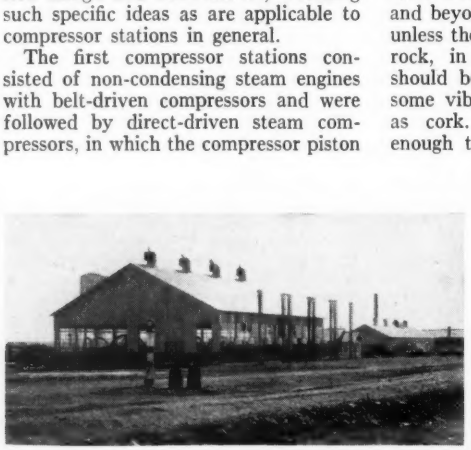


Fig. 1. This compressor station, built many years ago, has floor at grade level, no provision for basement

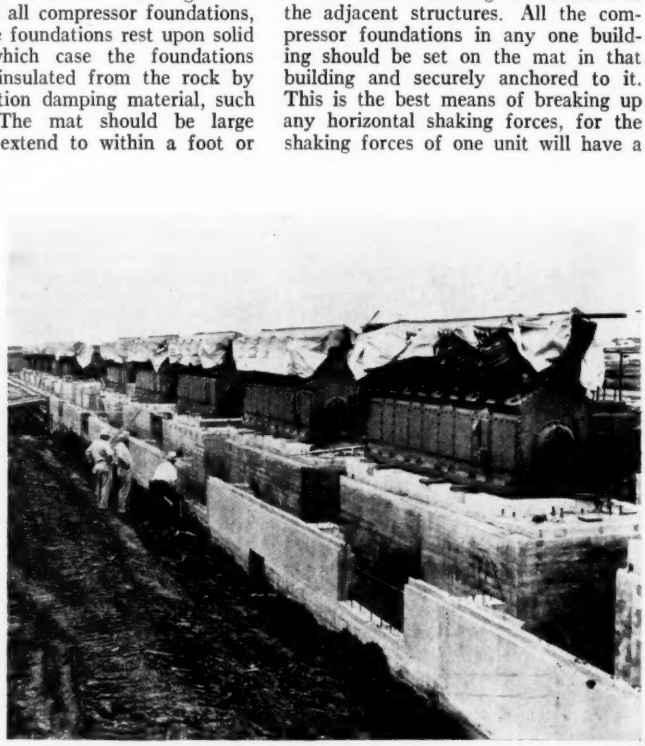


Fig. 2. Modern type construction with floor level well above grade level, permitting full-size basement windows for ventilation and easy access. Note compressor foundation ledges for carrying floor beams. Foundations spaced so no additional floor supports are required, leaving basement passage-ways unobstructed

Possibilities of future increased use of gas in industry point up importance of compressor stations . . . Here are general principles and details for planning them properly . . . Foundation details . . . Should you have a basement or not? . . . How to design the cooling system, get proper cooling water, prevent scale in jackets . . . Importance of the air filters and exhaust . . . Oil coolers and filters . . . How to figure piping correctly on basis of average flow to compressor . . . Safety devices . . . Station buildings

tendency to counteract the forces of another unless all units are synchronized with each other, a condition that does not exist in a compressor station except for short periods of time. The lower or tension side of the mat should be well reinforced and keys should be cast into the top of the mat at those surfaces where the compressor foundations are to rest, so as to tie the mat and the compressor foundations into one solid mass.

Because the mat and the foundations are poured at different times, care must be taken to be sure that the surface of the mat is free from dirt or scum and properly wetted, to assure a good bond between the foundation block and the mat. Enough reinforcing steel should be used across this joint to assist in the bonding between the two sections.

Basement Or No Basement?

The question of whether or not to have a basement in a compressor station has been discussed pro and con for many years; but the convenience of a basement outweighs any additional cost for its construction.

The station basement should be built high enough and the basement piping be so arranged as to allow plenty of head room and working space around the piping, and should be provided with facilities for proper ventilation. Most basements are now built with but half of their height below ground level which allows for the installation of full size windows in the basement and makes it available for the storage of spare parts and operating stores such as oil and waste. Room for placing a bench for light repair work can also be found in the basement, making it handy for the repair crew on rush repair jobs.

Foundation Details

The compressor foundations should be keyed into the mat and well reinforced at all points subject to tensile stress. All foundation bolts should be surrounded by a pipe or duct whose diameter is at least 2.5 times the diameter of the bolt and extends into the foundation for a distance of at least 15 times the diameter of the bolt. These ducts should be kept free of concrete when the foundation is poured. This is done to facilitate lowering of the engine base over the foundation bolts. On the large horizontal units, where the foundation bolts are very long, the duct runs down to the foundation washer so that the bolt can be removed when the engine main frame is skidded onto the foundation.

The foundations are generally built with a step or shelf in them approximately 14 in. below the floor line, the step acting as a support for the floor beams. A step or shelf may also be put in the building wall foundation for the same purpose. When the floor is poured, a strip of insulating material, such as pitch-impregnated felt, at least one inch thick, is put between the edge of the floor and the foundations. This prevents any horizontal forces from being transmitted from the engine foundation to the building wall. By judicious spacing of the foundations, no additional supports for the engine-room floor will be necessary in the basement, leaving all basement passageways unobstructed.

When grouting an engine, the grout should never exceed 1½ in. in thickness and should be practically the same thickness over the entire foundation top. This eliminates excessive and uneven shrinkage, which might throw the unit out of line after the grout has set. All leveling wedges and plates should be removed after the grout has set.

Cooling Water Systems

The days when the engine cooling water is taken from a creek, pond, or open cooling-tower basin should be over for all gas engine installations except those of the most temporary nature. In the earlier gas engine installations, the temperature differential between the incoming and outgoing water ran anywhere from 40 to 100 F. These large temperature differences caused undue strains in the engine cylinders and cylinder heads and no doubt were the cause of many a piston seizure, where the piston was not water- or oil-cooled. Present-day practice is to hold the temperature differential at 15 F or less, with resultant better operation and lower maintenance costs. This involves the use of larger circulating pumps than formerly, but in the long run will decrease the maintenance sufficiently to offset the cost of the additional pump capacity.

Closed Systems Ideal

The ideal system is a closed cooling-water system. In an open cooling-water system where the water is cooled by means of a cooling tower, the daily make-up water is never less than 5 per cent, which causes an accumulation of mud or sludge in the cooling water tower basin great enough to necessitate the draining of the system and cleaning of the tower basin every few months if formation of scale in engine jackets and cylinder heads is to be held to a minimum. Then, too, the faculty of water in an open system of absorbing oxygen in the form of air makes the air-saturated water highly corrosive when it is heated and the oxygen is released in the engine jackets and heads. This is particularly true in water-cooled piston rods, for the oxygen will attack steel with greater avidity than cast iron.

In a closed system, the amount of make-up water is almost negligible, provided the system is free from leaks. The most reliable closed system is one in which the pump draws the water from the overflow tank or standpipe and forces the water through the heat exchanger and the engine to the overflow in the overflow tank or standpipe. The

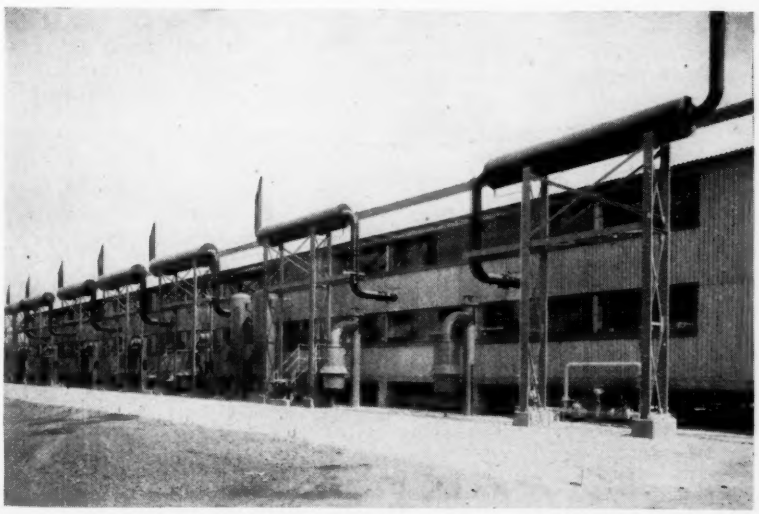


Fig. 3. Modern station with construction planned to provide full basement. Location in warm climate makes basement windows unnecessary

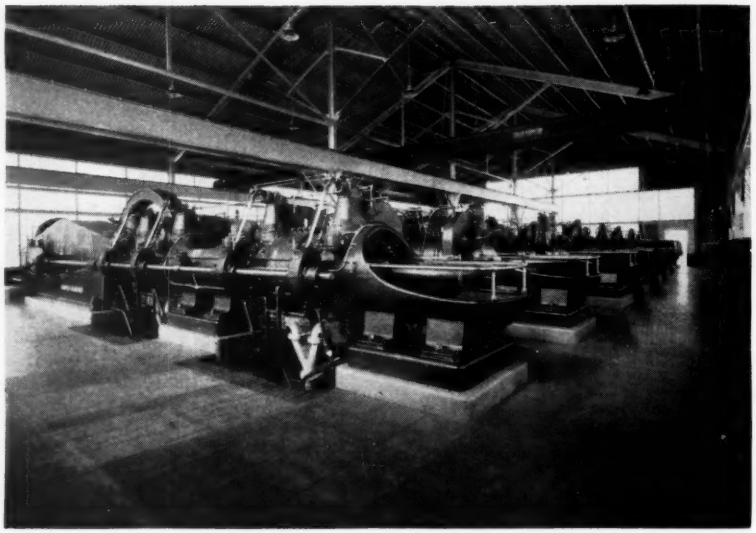


Fig. 4. Station interior, showing large floor area required for slow-speed engines. These twin-tandem units develop 1300 hp each

overflow tank or standpipe should have its cover vented to the atmosphere and be so constructed that the water surface exposed to the air is a minimum. The overflow line from the engine should enter the standpipe a short distance below the normal level of the water in the standpipe, so as to prevent any splashing, because this would increase the amount of air absorbed by the water. But the outlet of the overflow should be high enough to provide for a continuous slope upwards from the engine to the standpipe. In fact, all piping should have an upward slope from the time it leaves the pump discharge until it enters the standpipe. This will release any entrained air or gas in the cooling-water stream.

If, due to necessities of design, the water piping must deviate from a continually rising line at any point, an automatic air vent or a small bleeder line should be installed at the high point in this line.

Cooling Water And Water Treatment

The system should be filled with treated water of approximately the following analysis:

Dissolved Oxygen: — Preferably zero, but not over 0.05 cc per liter
pH value: — Not less than 8
Oil: — None
Suspended solids: — None
Hardness: — Calcium and magnesium sulfates added, not over 15 ppm
Calcium and magnesium carbonates added, not over 75 ppm
Organic matter: — Not over 5 ppm
Chloride: — Not over 6 ppm in terms of Chlorine

Any make-up water should be of the same analysis.

There are many types of water treatment, the simplest being the zeolite process which removes the calcium and magnesium compounds by substituting sodium for the base in these compounds. The lime-soda process, which changes the soluble calcium and magnesium bicarbonates to insoluble compounds that are precipitated and filtered out, is somewhat more complicated and expensive than the zeolite process but may also be more efficient in some cases. These treatments remove the scale-forming compounds from the water. In addition to these, there are treatments with potassium or sodium dichromate to prevent oxygen corrosion, and treatments with chlorine or copper sulfate to prevent the growth of algae or other micro-organisms.

Importance Of Preventing Scale

One cannot stress too heavily the necessity of supplying as near as possible a scale-free and non-corrosive water to an internal-combustion engine. Scale in the water jackets of a gas engine can produce more operating ills than is normally thought possible. When we consider that $\frac{1}{32}$ in. of scale has the same thermal conductivity as 4 in. of cast iron, one begins to see how a very thin coating of scale can slow down the heat transfer between the hot gases in the engine cylinder and the water in the cylinder jacket. For this reason, even the best of treated waters are not good enough for continuous operation without a constant check on their condition.

How To Control Water Temperatures

To maintain a nearly constant differential between the inlet and outlet water temperatures, an automatic bypass should be installed around the heat exchanger. This bypass is actuated by the temperature of the water leaving the engine. If the outlet temperature of the unit should fall below the predetermined temperature, the bypass will allow enough water to bypass the cooler to raise the temperature at the engine outlet. This type of regulation is based on a heat exchanger large enough to take care of the entire output of the engine at peak loads with a constant supply of raw water.

Another method of obtaining the same result is to regulate the flow of raw water to the heat exchanger by means of an engine outlet-water-temperature-controlled valve. By this means, more or less heat is taken from the jacket water ahead of the engine and this keeps a constant temperature at the outlet. This system requires a raw water pump of sufficient capacity to take care of the cooling at peak conditions. The system is generally used where raw water is used for other purposes and an abundant supply is available.

Oil Coolers Should Have Separate Water System

For best results, the oil coolers should be served from a water system separate from the main-engine water supply. In an engine operating with oil-cooled pistons, it is necessary to carry the temperature of the lube oil at a lower level than that of the jacket water. The reason for this is to keep the piston from seizing. The clearances between the cylinder wall and the piston are kept at a minimum in an oil-cooled piston and if the piston should be raised to a greater temperature than that of the jacket water, the piston would expand and take up this clearance, causing piston seizure.

The minimum temperature differential between the lube oil and jacket water should be 5 F but it should be carried higher than this for the operator's peace of mind. In present-day units, the jacket water temperature off the engine can be carried in the neighborhood of 160 F with the lube oil temperature to the oil cooler at 140 F.

All water piping should be calculated for water velocities not exceeding 4 ft per second. In case this velocity creates too great a pressure drop, due to long pipe lines, the pipe size should be increased. The quantity of water necessary to cool an installation containing 1000 Bhp in main units is 700 gpm for a 15 F differential, and 1050 gpm for a 10 F differential. These quantities contain the cooling water necessary for the auxiliary engines and other auxiliaries requiring cooling in an average station, and are based on the heat dissipation of an oil-cooled-piston, two-cycle engine with water-cooled exhaust manifolds.

How To Design The Vital Air Filters

One of the most necessary accessories in a gas engine compressor station is an air filter on the free-air line to the engine. Until one has seen the effects of an air filter, it is hard to believe that stations located just west of the Alleghanies should require one. But in most cases the atmosphere around a gas compressing station carries enough abrasive grit to warrant the installation of an air filter.

An excellent example of what an air cleaner can do was indicated by an inspection of a compressor station located in the dust bowl. In this station, the

No. 1 unit was equipped, about one year after it was put into service, with a Phoenix constant-effect air filter, having a constantly-traveling filter belt moving through an oil bath at its lower turn. The other three units in this station were left without air filters. After this station had been in operation for 11 years, the maximum wear in any cylinder on the unit having the air filter on its free air line was 0.033 in. with an average wear over all eight cylinder ends of 0.025 in., making the average yearly wear for the unit a little more than 0.002 in. per year. This is excellent operation.

The other units in this station, operating under the same conditions but without air filters had an average wear of 0.018 in. per cylinder end per year, or an average total wear of 0.198 in. per cylinder end throughout the 11 years of operation.

In cases of this kind, the air filter would allow the engine with the filter attached to operate nine times as long as the engines without the filter before the reboring point was reached. This is concrete evidence that the cost of the air filter is repaid many times over by reducing the wear on the engine cylinders.

In installing an air filter, care must be taken to provide an air filter large enough so that the restriction produced by the air filter does not create too great a pressure drop between the outside atmosphere and the engine cylinder. This must be watched more closely in a two-cycle unit than in a four-cycle unit, because a slight pressure drop in the air going to the scavenging cylinder of a two-cycle unit will produce a greater effect on the maximum power the engine can develop than it will in a four-cycle unit. In both two-cycle and four-cycle units, any restriction in the free-air line will tend to enrich the mixture in the cylinder and cause the engine to run hotter than normal. This condition may cause overheating and seizing of the pistons.

The two-cycle engine is more critical in regard to the length of its exhaust pipe than the four-cycle engine. All two-cycle engine builders have conducted experiments on their product, the results of which are available to the purchaser. These experiments were conducted to ascertain the most favorable length of exhaust line to use on any one particular unit. If a muffler is included in the exhaust line, its effect should also be included, for it will affect the length of the exhaust line between it and the engine and between it and the atmosphere.

At no time should the exhaust line be anchored at the end away from the engine unless a trouble free expansion joint is inserted between the exhaust muffler and the engine. Most exhaust lines are so constructed as to relieve the engine of all strains due to the expansion of the exhaust line.

How To Design Oil Cooler And Filters

If the compressor is equipped with oil-cooled power pistons, an oil cooler is a necessity and should be so chosen that the pressure drop through the cooler is at a minimum with a maximum heat exchange capacity. These coolers should be constructed so that the tube bundle can be removed for cleaning. No matter how clean the filter may keep the oil, there will always be some sludge settle out in the oil cooler. The cooling water circuit that supplies the water to the oil cooler should be divorced from the main compressor circuit, for there may be times when the compressor is forced to operate at higher temperatures than are correct for the oil system.

Since most oil-cooled-piston engines use the circulating system lube oil as a coolant, the lube oil system must contain filters that are capable of taking care of the full flow of the lube oil. In addition to this, most units also have a waste type bypass or bleeder filter that removes the finer particles and sludge from the lube oil. As these filters are very efficient, the outlet from them may be bypassed through the cylinder lubricator tanks, so as to keep a constant level in these tanks.

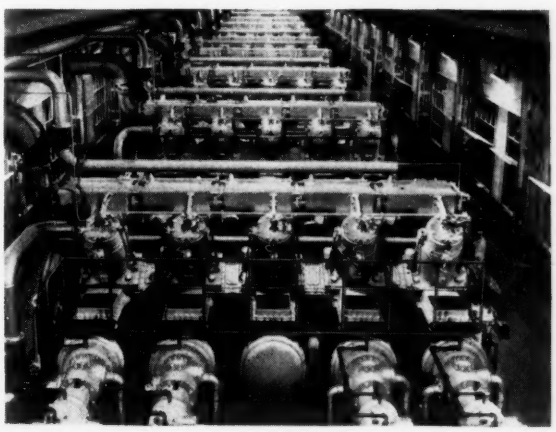
In the past the amount of gas delivered by a compressor station has been used as a basis for calculating the pipe sizes used in that station. This method of calculation assumes that the gas is flowing in a continuous stream from the compressor during the time it is in operation. But what actually happens is that the compressor takes in gas during only a portion of its entire stroke and discharges the gas during only a portion of the next stroke. The amount of gas taken into the compressor cylinder and delivered by it during one revolution is dependent upon the volumetric efficiency of the compressor cylinder. However, the rate at which the gas is taken in or discharged depends upon the velocity of the piston during the time the gas is flowing to or from the compressor cylinder.

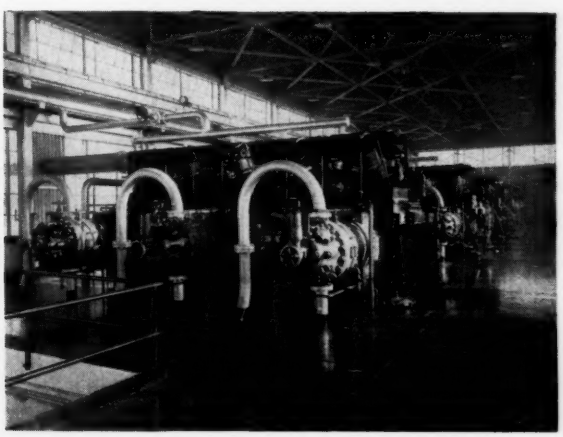
Correct Method Of Figuring Pipe Sizes

For example, in a double-acting compressor cylinder having a piston displacement of 100 cfm when operating at a speed of 300 rpm and having a volumetric efficiency of 85 per cent during the suction stroke and a volumetric efficiency of 35 per cent during the discharge stroke, the cylinder will then take in 0.2833 cu ft of gas during one revolution of the crank and discharge 0.1167 cu ft of gas during the same period. If the compressor cylinder driving mechanism has a crank-to-connecting-rod ratio of 1 to 5, the time consumed during the suction stroke, measured in the time of one stroke, will be 72.14 per cent of the forward stroke and 76.74 per cent of the return stroke or 74.44 per cent of the time of one revolution.

Since the time of one revolution is 0.003333 min, the time required for the compressor cylinder to take in 0.2833 cu ft, which is the quantity of gas taken in during one revolution, is 0.002481 min. Then the average rate at which the compressor cylinder takes in gas is 114.3 cfm. This means that the suction pipe leading to the compressor cylinder must be capable of handling gas flowing at the rate of 114.3 cfm instead of 85

Fig. 5—A and B. Two main line compressor stations, showing steel framework of buildings and relatively small space per horsepower required for modern medium-speed engines. Each engine shown develops 1000 hp





cfm; for 114.3 cfm is the average rate of flow to the compressor cylinder during the time that it is taking in gas. If the pipe is calculated on 85 cfm it will have 74.4 per cent of the proper area. In the same manner, we find that this compressor cylinder will discharge gas during 40.44 per cent of one revolution or 0.001348 min during which time 0.1167 cu ft are discharged at an average rate of flow of 86.6 cfm. A discharge line based on the discharge capacity of 35 cfm would have 40.4 per cent of the required area.

Take Account Of Pressure Drops

If the pipes leading to and from a compressor cylinder are too small, the pressure drop through these lines will decrease the capacity of the compressor cylinder and will increase the power to compress a unit volume of gas. This is often the reason why compressor stations that are correctly designed for compressor horsepower and capacity do not deliver their rated capacity or are overloaded when put into operation.

The intercoolers in a two-stage installation, and the after-coolers in any installation, should be calculated for pressure drop, using the average rate of flow as outlined above. A restriction here can cause as great a power and capacity loss as too small a pipe size. In a station containing more than one compressor, the headers connecting these compressors should be large enough to take care of the gas flowing to or from the compressor cylinders when all units are synchronized, basing the rate of flow upon computations similar to those given above. If this is not done, the capacity of the station will be decreased and the horsepower per unit volume increased. Horespower losses have reached as high as 33 per cent of the productive horsepower in some instances where the piping was known to be undersize. Where two or more compressor cylinders on the same service are mounted on the same unit, the installation of a large header supplying all of the cylinders will increase the efficiency of the unit. On single cylinders, the installation of an intake and a discharge tank will increase the compressor efficiency and also tend to mitigate any pulsations set up by the compressor.

Theoretically it requires less horsepower to compress gas in a two-stage compressor than in a single-stage compressor for any set of conditions, but, due to the additional mechanical friction and valve losses, this is not true actually. The two-stage horsepower curve lies above the single stage curve until approximately 4.5 compressions are reached and from this point the two-stage installation will require less horsepower than the single-stage. However, the dividing line between single and two-stage compression in any particular installation depends not only on the installed horsepower but also on the economies of the installation, and this in turn depends upon so many variables that it is a lengthy problem in itself.

What About Safety Devices

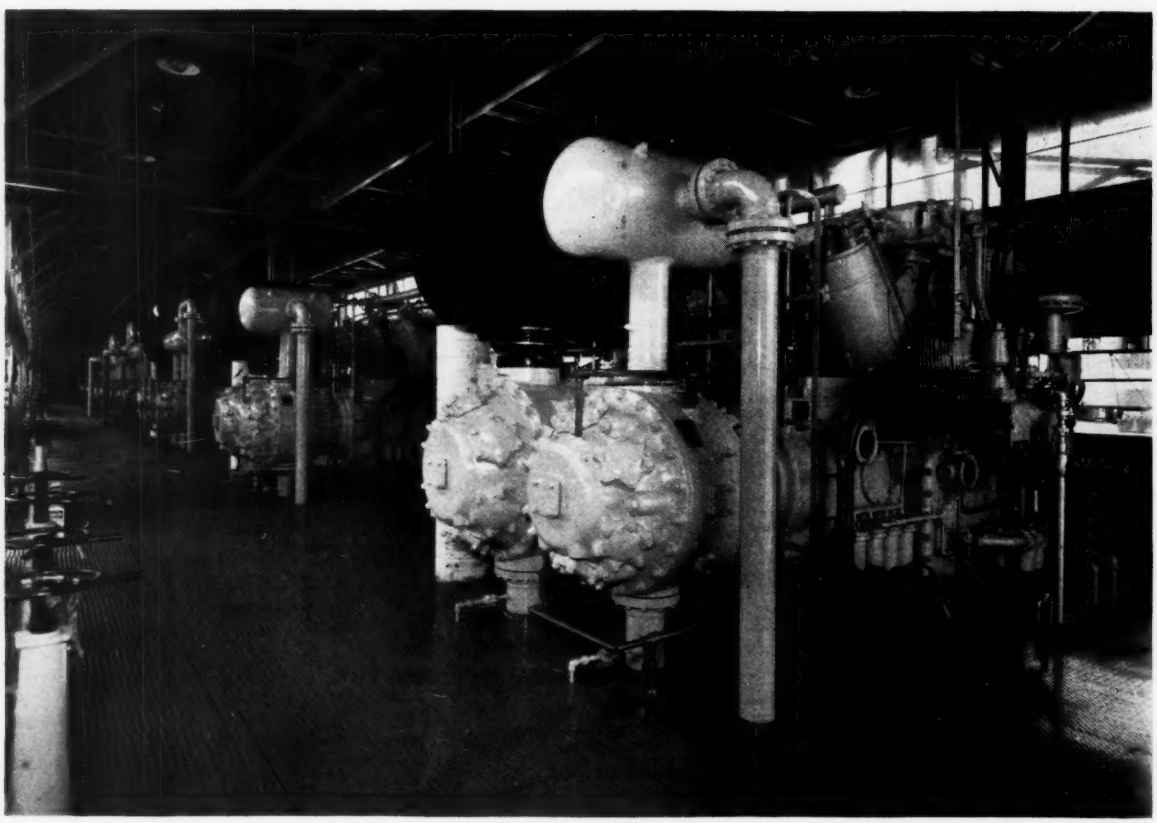
The newer compressors can be equipped with a number of safety devices and controls, of which the common safety devices such as the overspeed stop, and the safety stops actuated by low lube oil pressure, high cooling water temperature, and subnormal cooling water flow, have been in existence for some time. Now we have safety devices that can be attached to the bearings that will shut down the unit if the bearing temperature becomes excessive, or if the play in some of the moving parts becomes too great.

The number of controls that can be used on a present day compressor are many, and with various combinations of them practically any type of operation can be controlled. The output of a compressor may be regulated by the suction pressure, the discharge pressure or the quantity of gas compressed. The quantity of gas compressed can also be varied automatically by changing the speed of the compressor up to a certain point, and by clearance pockets from there on, until the output of the compressor is zero.

The torque of a compressor can be controlled so that, in an installation

(Continued on page 126)

Fig. 6. In this processing plant, the one building houses compressors of three horsepower sizes handling a variety of gases. Note surge drums for lessening pulsations set up by compressor



Crushing Coal for the Power Plant

By **WILBUR G. HUDSON**, Consulting Engineer

Coal handling layout should provide for crusher installation, even though properly sized coal normally available . . . Might need it if circumstances change . . . Details of types of crushers; single and double-roll; hammermill or rolling ring; breaker or hammermill breaker . . . Capacities, speeds, horsepower of drives . . . How feeders should be installed in relation to crushers . . . Where should the crusher be located and how controlled?

UNDER NORMAL conditions, the purchasing department can get deliveries of any size of coal specified, and the necessity for a crusher is not what it was when we got mine-run or nothing. However, circumstances may at some time make a crusher desirable, so the coal handling layout should provide for its later installation, preferably with the chute from the feeder by-passing the crusher during normal operations. See Fig. 1.

Single-roll and Double-roll Crusher

Crushing to stoker size is routine with a single-roll or double-roll crusher. The diameter and length of roll are determined not only by the capacity, but by the size and hardness of the lumps. Thus a single-roll 26 by 30-in. crusher is rated, when crushing to 1⅝ in. ring size, as 75 Tph (tons per hour) of hard bituminous coal with no lumps larger than 12 in.; 95 Tph of medium hard coal with no lumps larger than 14 in.; and 115 Tph of soft coal with 16-in. maximum lumps.

There is another factor; crushers are rated on the assumption that all the coal goes through. If there is a grid ahead of the crusher, the Tph is substantially different. If the feeder delivers 90 Tph of mine-run, but ⅓ is screened out as undersize, the job of the crusher is to reduce 60 Tph of lumps. If we screen out ⅔ as undersize, the crusher capacity requirement is 30 Tph of lumps. Or again, if we feed 70 Tph from which we can screen out ⅓ undersize, the crusher does the same job as when we feed 140 Tph but screen out ⅔ as undersize; viz, 47 Tph of lumps.

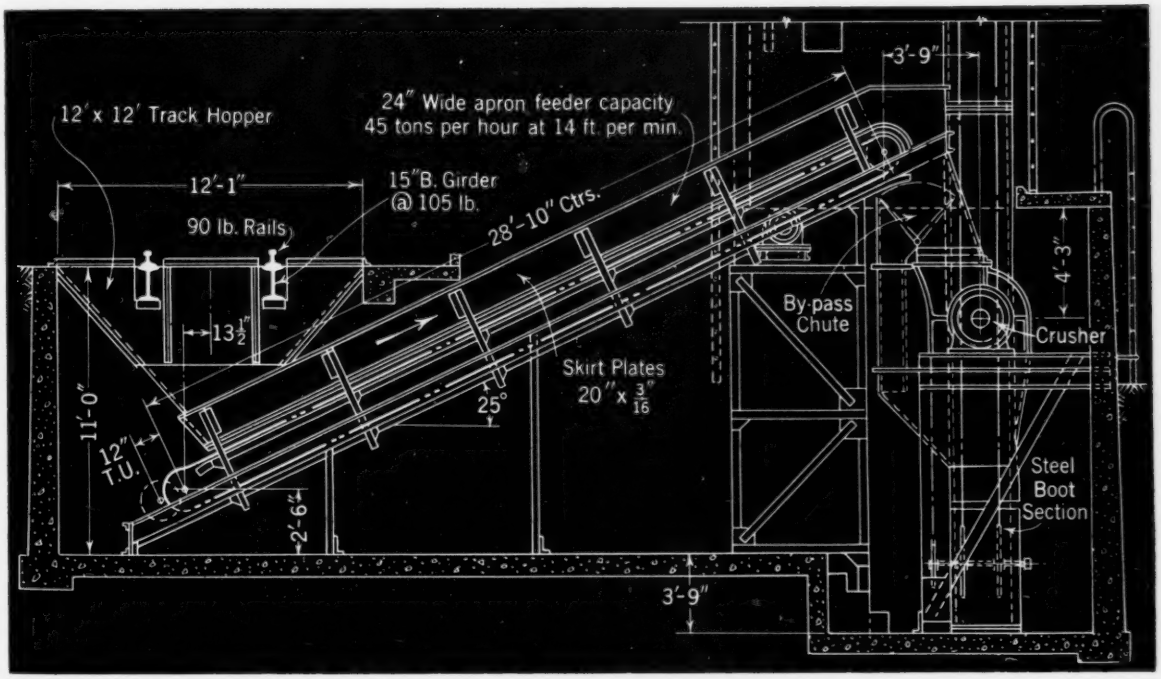
If an installed crusher should be found shy of capacity, perhaps because of plant expansion, there is no objection to increasing the speed 50 per cent or so above the tabulated speeds. The capacity may be increased also by blocking back the roll if there is no objection to a somewhat larger product.

The standard double-roll crusher, Fig. 2, has one roll-shaft geared to a countershaft and in turn driving the other roll-shaft through long tooth gears. This shaft is held in position by spiral springs, providing an automatic release should an unbreakable lump enter. Roll speeds range from 115 to 130 rpm.

The single-roll crusher has the roll geared to a countershaft but breaks down the coal against a ribbed breaker plate, which may yield in an emergency. The roll speeds range from 50 to 100 rpm.

Fig. 1. Typical layout for track hopper, apron feeder, hammermill and double-strand bucket elevator

So long as the coal is of suitable fineness, the crusher is by-passed. When it contains lumps, the flap gate is thrown to the left and all material goes through the crusher. Frequently this occurs when coal is brought from reserve ground storage in freezing weather. The feeder, if suitably designed with non-magnetic skirt boards, may be equipped with magnetic head assembly to drop fragments of tramp iron beyond the flap gate of a roll crusher. The hammermill, however, will trap out such material. Here the feeder is chain driven (shown in part) from the foot-shaft of the elevator to interlock the two machines.



Roll crushers, although the countershaft has a heavy flywheel, subject the motor to shock unless there is a flexible connection between the two, so a multiple V-belt drive is preferable to a geared or silent chain. Further protection may be through a shear-pin between drive wheel and its shaft.

The single-roll crusher may be adjusted while running. The standard two-roll crusher must be stopped when making adjustment of the spring-release shaft. The pinching action of two rolls enables the double-roll crusher to handle a succession of large lumps better than the single-roll.

Occasionally one or more of the roll teeth may be broken off. If the teeth are cast or malleable iron, repairs may be made by drilling into the roll and driving home a stub. If the teeth are of steel, a new tooth may be welded in place.

The limit of reduction with a roll crusher is to ⅞-in. cube, secured by small teeth or transverse ridges integral with the roll. However, for fine crushing the hammermill is preferred. Where a minimum of undersize is desired, opinions differ as to whether the double-roll or single-roll crusher is best. Trials by the author with screened 4 in. lump coal, soft, medium, and hard, through a 30 by 24-in. double-roll and a 30 by 24-in. single-roll, after the rolls had been set by trial to give stoker size, gave undersize of 17 per cent and 45 per cent respectively. No doubt the results vary with different coals.

The Hammermill or Ring Crusher

The hammermill or rolling ring crusher, Fig. 3, is essentially a high-speed machine, usually direct connected through a flexible coupling to the motor. The rotor has circumferential rings or hammers thrown out radially when up to speed, but free to yield on impact with an unbreakable lump. The coal is ground against a fixed plate and passes out through a fixed grid. The outstanding advantage of this crusher is that hard fragments, tramp iron, wood, and the like are trapped out; and material harmful to the pulverizers, such as rags, hay, waste, are either ground up or eventually trapped. The speeds range from 600 to 720 rpm. The power requirement is greater than for a roll crusher of corresponding capacity.

The Breaker

The Bradford breaker, also has the good feature of culling out objectionable material and another good feature—slow speed. As shown in Fig. 4, it resembles a rotary screen, except that there are longitudinal shelves which lift the lumps and drop them as the cylinder revolves at 20 to 25 rpm. There are a few spaced deflector plates, which work the material along until the refuse, if any, spills out at the far end. It costs two or three times as much as the roll crusher and so as a rule is specified for larger capacities—up to 600 Tph.

Its capacity for a given size of cylinder is increased by mounting a small hammermill within the discharge end of the cylinder as in Fig. 4. Thus a 7 by 14-ft Bradford breaker is rated at 55 to 100 Tph, while as a breaker-hammermill, its capacity is more than doubled. The minimum size of output is ¾ in. by 0, which is small enough for a unit pulverizer.

When coal is received by rail through a track hopper, it is necessary to pro-

Crusher Size (Diameter x Length)																							
Size of Product		24" x 24"			24" x 30"			30" x 24"			30" x 30"			30" x 36"			30" x 42"					
		Grade of coal and maximum lumps																					
Ring Size	Cube	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft				
		14	16	18	14	16	18	16	18	20	20	22	24	20	22	24	20	22	24				
1 1/4	⅞	10	20	25	10	25	30	25	35	45	30	45	50	35	55	70	45	65	85				
		25	40	50	30	50	60	45	75	105	50	95	135	70	115	165	85	135	190				
1 1/2	1	15	25	30	15	30	35	30	45	55	35	50	60	40	65	80	50	75	95				
		30	50	60	35	60	75	55	90	125	60	110	155	80	130	185	95	155	215				
1 5/8	1 1/8	20	30	40	25	35	50	35	50	60	40	60	75	50	75	90	55	85	105				
		40	60	75	50	75	95	60	100	140	75	125	175	90	150	210	105	175	245				
2	1 3/8	25	35	50	30	45	65	40	60	70	50	75	100	60	90	120	70	110	140				
		50	75	100	65	95	125	70	130	160	100	160	200	120	195	240	140	230	280				
3	2	30	50	60	35	65	75	45	75	105	60	90	130	70	110	155	85	130	180				
		60	95	130	75	120	150	105	150	215	130	195	265	155	225	300	180	270	360				
Minimum motor size		10 hp			10 hp			15 hp			20 hp			25 hp			25 hp					
Roll r.p.m.		Std.		Max.	Std.		Max.	Std.		Max.	Std.		Max.	Std.		Max.	Std.		Max.				
		60		100	60		100	50		75	50		75	50		75	50		75				

* Courtesy Link Belt Co.

Table I. Capacities of Single-roll crushers in tons per hour

The tabulated capacities assume mine run coal, from which smaller sizes have not been removed. If undersize has been removed ahead of the crusher, add the tons removed to the tons through the crusher when rating the crusher.

In the above figures if 2/3 the coal to be crushed is larger than 3" ring size, use the top row of capacity figures. If 2/3 the coal is already undersize, use the bottom row of capacity figures. Example: Select a crusher for 60 Tph hard bituminous, two-thirds of which is already under 3" ring size, to be crushed to 90% of 1½" ring size and smaller. Maximum lumps not over 20".

For 20" lumps, roll diameter should be at least 30". Since 2/3 is under 3" use lower row of capacity figures, and specify a 30" x 30" crusher.

Crusher Size (Diameter x Length)																							
Size of Product		20" x 18"			26" x 24"			28" x 24"			30" x 24"			30" x 30"			36" x 36"					
		Grade of coal and maximum lumps																					
Ring Size	Cube	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft	Hard	Med.	Soft				
		6	8	10	12	14	16	14	16	18	14	16	18	14	16	18	16	18	20				
1 1/2	1	30	40	50	50	65	80	50	65	80	55	70	85	70	90	110	90	110	130				
1 5/8	1 1/8	35	45	55	60	75	90	60	75	90	65	80	100	80	100	120	100	125	150				
2	1 3/8	40	50	60	70	85	100	70	85	100	75	90	110	95	115	135	115	145	175				
3	2	50	65	80	85	105	125	90	110	130	100	120	140	120	150	175	150	185	220				
Motor		7 1/2 hp			15 hp			15 hp			15 hp			20 hp			30 hp					
Roll r.p.m.		130			120			115			115			115			110					

Table II. Capacities of double-roll crushers in tons per hour

The tabulated capacities are based on mine run coal from which smaller sizes have not been removed. If undersize has been screened out ahead of the crusher add the tons removed to the tons through the crusher when rating the crusher.

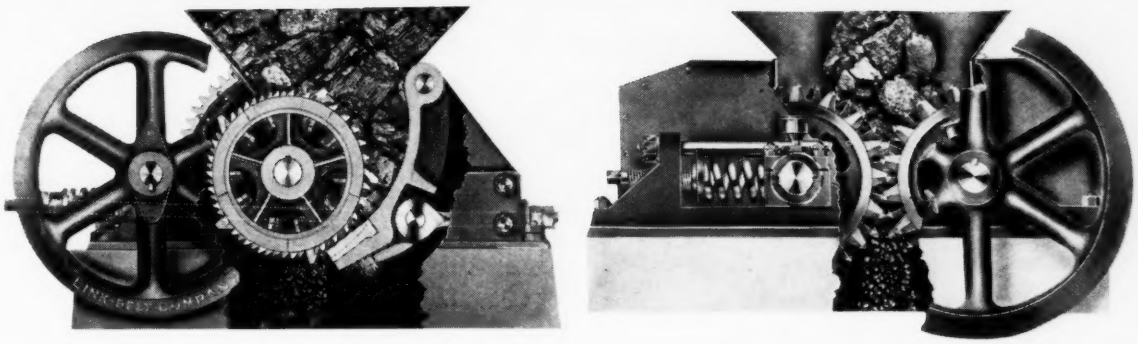


Fig. 2. Single and double-roll crushers. Each machine is preferably driven through countershaft and V-belt. Each has the roll protected by the shaft bearing or the breaker plate, held in position by a spiral spring. The fineness of the product is adjusted in the single-roll by shifting the position of the breaker plate with reference to the crushing roll. In the double-roll, the adjustment is made by shifting the spring-release roll shaft, inserting or removing filler plates behind the bearings. (Courtesy Link Belt Co.)

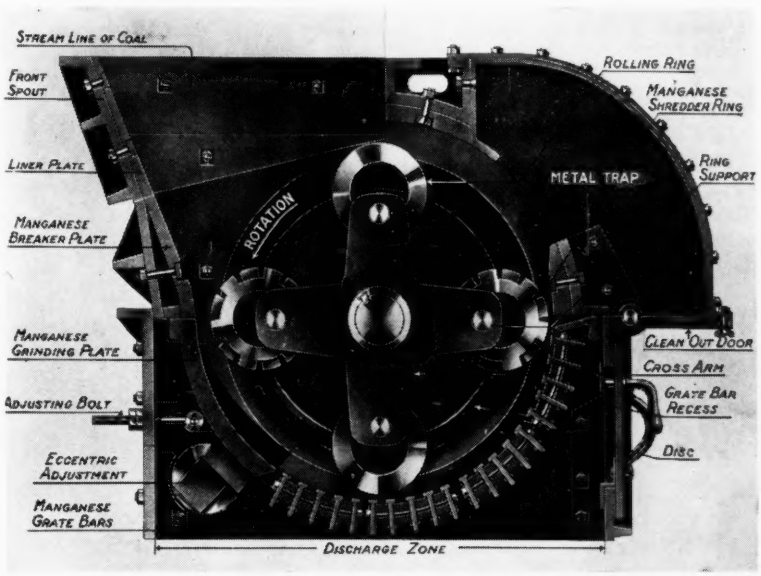


Fig. 3. The hammermill or rolling ring crusher with automatic trap. Two types of ring hammers are shown. The maximum size of the product is determined by the spacing of the grate bars. The hammermill usually is direct connected to the motor through a flexible coupling. For capacities, see Table III, page 82. (Courtesy American Pulverizer Co.)

vide one of the several types of feeder to equalize the flow. If large lumps are infrequent, some saving can be made by spacing grid bars across the hopper, which will pass most of the coal but hold the occasional lump for cracking by a sledge. When specifying the contemplated crusher, it is advisable to state that 90 per cent of the product, rather than 100 per cent shall pass through a screen of stated mesh, as otherwise the manufacturer naturally will quote on a crusher larger than may actually be required.

The reciprocating feeder is the old standard, but it has some objections. It is not self-clearing, for when the head of coal in the track hopper is reduced, the remainder pumps up and down and must be shoveled out, unless the reciprocating plate is steeply inclined.

The apron feeder has the advantage that it may have indefinite length and may curve upward to reduce the depth of excavation. It has a bad feature in that when the coal is wet a residue spills down from the return run.

The vibrating, electro-magnetic feeder is becoming a preferred device. It re-

(*Continued on page 82*)

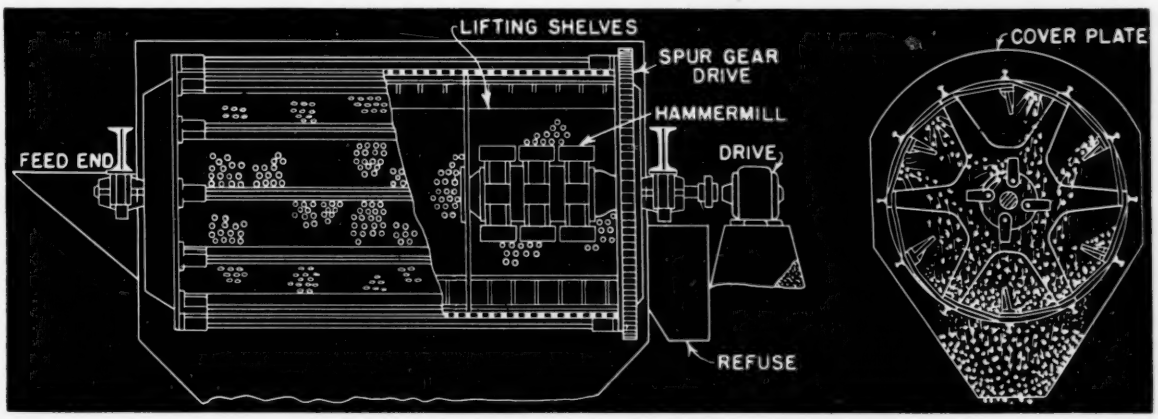


Fig. 4. The breaker-hammermill. Undersize passes through the screening plate in the first two-thirds of its length and the hammermill breaks up any lumps that have escaped the tumbling action of the breaker. Unbreakable lumps, rags, wood, hay, etc. pass out through the refuse chute. For capacities, see Table IV, page 82. (Courtesy Pennsylvania Crusher Co.)

How to Evaluate Performance of Atmospheric Cooling Towers

By JAMES G. DE FLON

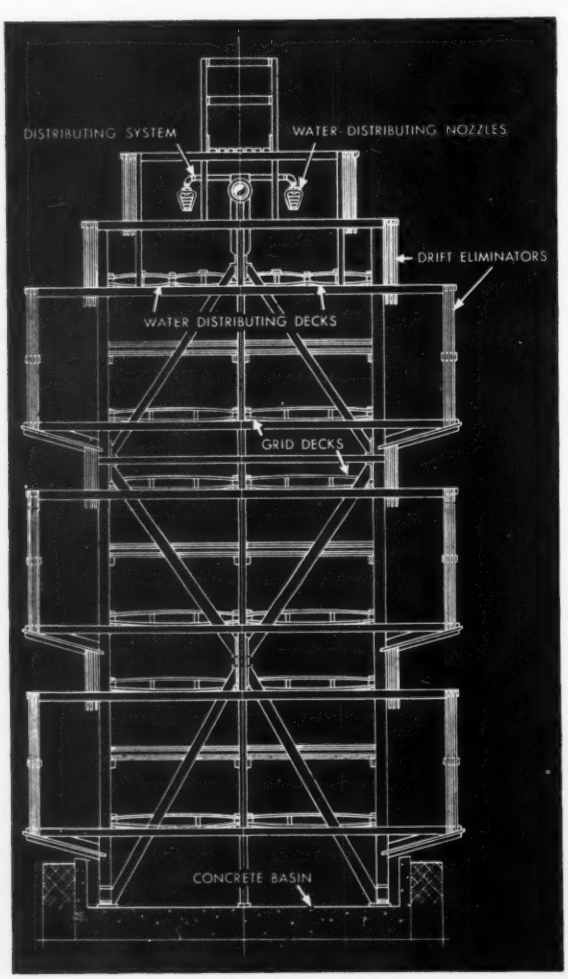
Chief Cooling Tower Development Engineer, The Fluor Corp., Ltd.

IN A PREVIOUS article in the June issue, the general principles for evaluating cooling tower performance were given and their application to the mechanical draft cooling tower was shown. This article will cover the performance of the atmospheric type of cooling tower.

As pointed out in the June issue, water may be cooled rapidly by spraying it into air and the important fact governing the design of a cooling tower is that the water cannot be cooled below the wet bulb temperature of the entering air.

Typical atmospheric cooling tower is shown in cross-section in Fig. 1. In atmospheric towers, the water is pumped to the top of the tower, where it is discharged through a distributing system. As the water begins its downward flow, it is broken up and redistributed by the decks that comprise the filling of the tower. This continually creates newly exposed cooling surface for the air to encounter as it passes horizontally through the tower. The redistribution insures even concentration of water throughout tower during its entire fall.

Although initial cost for an atmospheric cooling tower (designed for a 3-mile wind) is about the same as that for a mechanical draft tower, certain important limitations govern its performance. It must be located broadside to the prevailing wind in an exposed area. Any surrounding structures, hills or other barriers would tend to block off the wind.



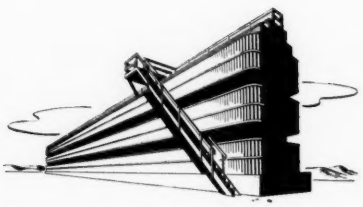
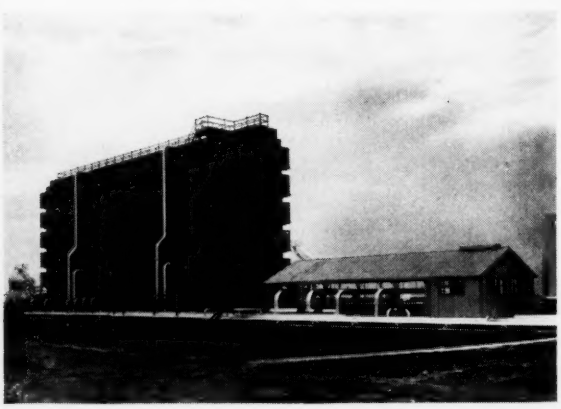


Fig. 1—left. Cross-section of atmospheric type cooling tower. Note drift eliminators on sides, designed to separate entrained water from discharging air stream and reduce airborne drift loss to minimum

Fig. 2—below. Atmospheric cooling tower installed at large Western cycling plant. Jacket water pump house at right



By using simple calculations and charts presented here, plant operator can quickly and easily estimate and compare performance of atmospheric cooling towers under different conditions . . . Relations between concentration, tower width, and height, wet bulb temperature, wind velocity, approach, temperature range . . . Calculations for an atmospheric tower . . . How to correct for changes in wet bulb temperature, tower height, wind velocity, approach . . . How to find tower size for different values of these factors . . . How to calculate cold water temperature for a given tower when conditions change . . . June issue showed mechanical draft tower calculations

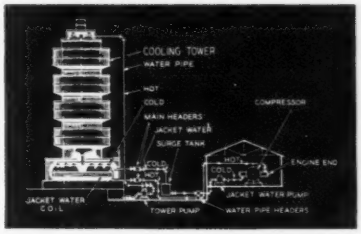


Fig. 3. Typical flow diagram for closed cooling system using a coil-type atmospheric tower

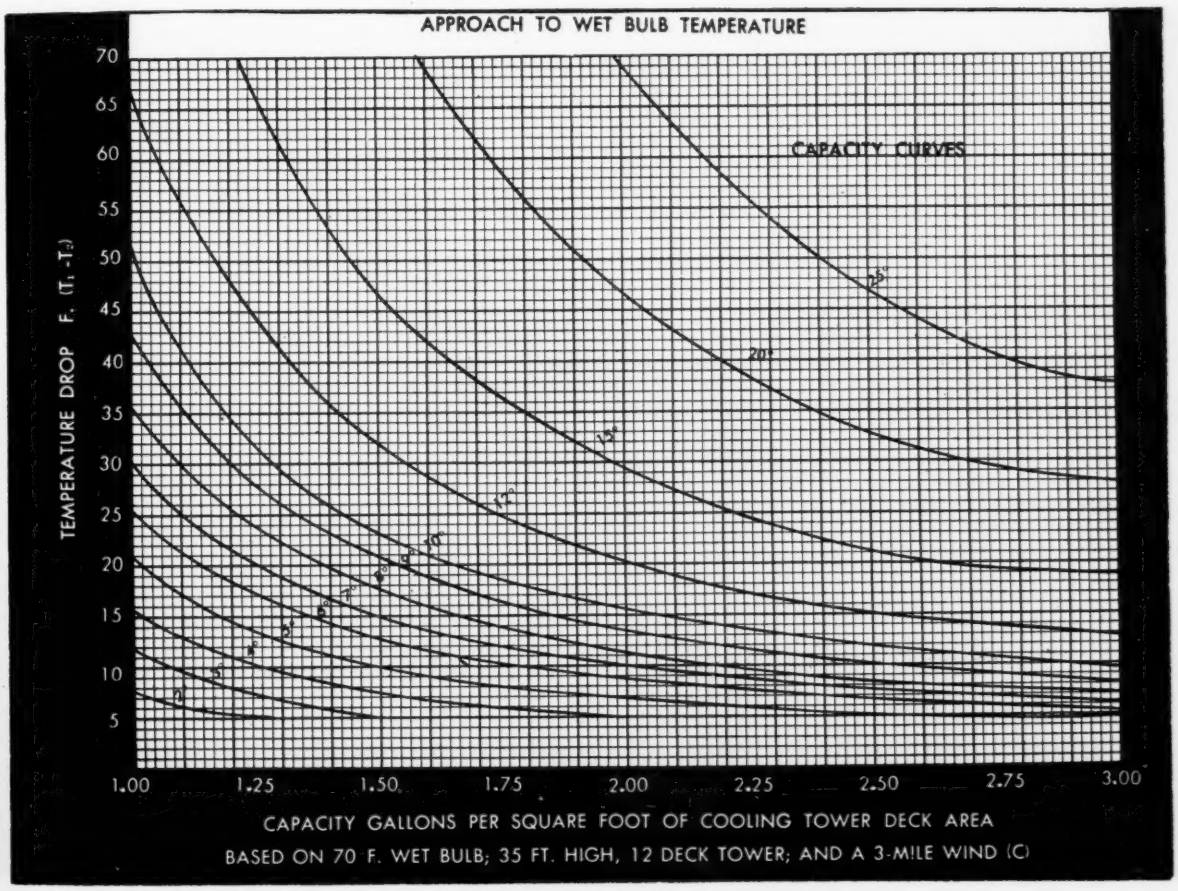
Originally, the main objection to atmospheric towers was the excessive spray loss occurring during periods of high winds. This high loss was caused by the lack of a method of separating the entrained water from the air in the conventional louver-type tower. As a result, most manufacturers now have solved this problem by incorporating drift eliminators into the louvers. A few typical examples of this type of tower are shown in Figs. 1, 2 and 3.

The method of determining the size and performance of an atmospheric type tower is shown on the accompanying charts, Figs. 4 to 8. The purpose of these charts is to show the method of estimating the approximate size of an atmospheric type cooling tower to meet a given demand.

The cooling capacity of any tower, with a given wet bulb temperature and wind velocity, varies with the water concentration. This concentration is the number of gallons of water per minute per square foot of ground area. Thus, the problem of calculating tower size becomes nothing more than obtaining the correct water concentration for one of chosen height, which will operate under certain wind velocity and wet bulb temperature. Once this water concentration factor is obtained, the area of a given height tower can easily be calculated by dividing the gallons per minute circulated by the concentration factor.

The concentration required to produce desired cooling depends primarily

Fig. 4. Capacity curves for atmospheric cooling towers. The purpose of this and the following charts is to show method of determining approximate size



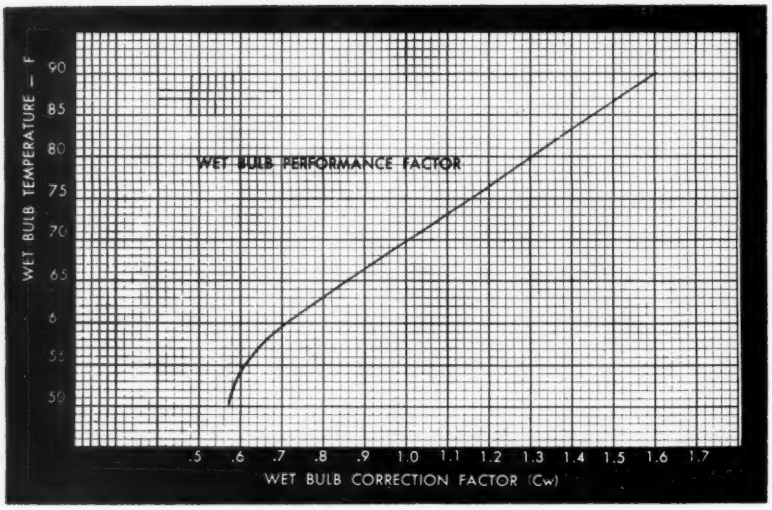


Fig. 5. Wet bulb performance factor for atmospheric cooling towers

on the following conditions:

1. Temperature Range ($T_1 - T_2$)
2. Approach to Wet Bulb Temperature ($T_2 - T_{wb}$)
3. Tower Height
4. Wind Velocity
5. Wet Bulb Temperature (T_{wb})

Curves for One Set of Conditions Must Have Correction Factors for Others

It is easily seen that because of the infinite number of possible combinations of these values, it is impractical, if not impossible, to have one curve from which to obtain the correct concentration factor. Figure 4 gives the required concentration for cooling water through a certain range and with a certain approach to the wet bulb temperature, *but* this curve assumes a wet bulb temperature of 70 F, tower height of 35 ft, and a wind velocity of 3 mph. Let us assume that the conditions given are unity. Then, if any of these values should change, the concentration would have to be corrected for the new conditions by using one or more of the correction factors shown on Figs. 5, 6, and 7.

How Variations Affect Concentration Factor

Let us see how a variation of any of the three aforementioned conditions would affect the concentration of water.

1. Wind Velocity. The higher the wind velocity the greater the amount of air that goes through the tower. This results in greater cooling. Therefore, when the wind velocity is higher, the concentration can be greater and still obtain equal cooling.*

2. Tower Height. In general, it is found in atmospheric, as well as in mechanical draft towers, that the greater the cooling range and the closer the approach to the wet bulb temperature, the higher will be the tower required to give sufficient time of contact between water and air to accomplish the desired cooling. In atmospheric towers, the performance is limited by both maximum and minimum water concentrations. If the water concentration falls below 1 gpm per sq ft of tower area, it will be necessary to employ the next size higher tower. This is because, in extremely light water concentrations, the water will not be uniformly distributed and the performance as predicted by the accompanying curves will not be achieved. If the water concentration should exceed 3 gpm per sq ft of tower area, it will then be necessary to choose the next lower tower. The higher water concentrations tend to blanket the tower and will not allow sufficient air to pass through to accomplish the cooling shown on the curves.

3. Wet Bulb Temperature. Theoretically, a cooling tower cannot cool water to a temperature lower than the prevailing wet bulb temperature. Being limited by this fact, one is more interested in the economic approach of the cold water temperature to the wet bulb temperature. Air has a greater capacity for absorbing heat at the higher wet bulb temperatures. At the lower wet bulb, air, in passing through the tower, must have a greater temperature rise to accomplish the same cooling. Therefore, to obtain the same approach at the lower wet bulb temperatures it is necessary to reduce the concentration.

How To Calculate Atmospheric Tower

To calculate the size of an atmospheric type cooling tower with effective width of 12 ft, the following general formula may be used:

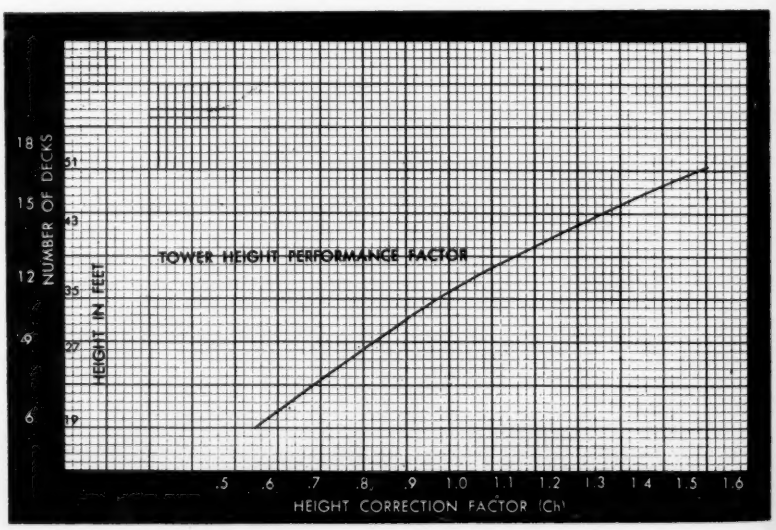
$L = (Gpm \times W) \div (C \times 12 \times C_w \times C_h)$

in which

L	= Length of tower in feet.
Gpm	= Quantity of water in gallons per minute.
W	= Wind correction factor.
C	= Concentration of water per square feet of cooling tower area.
C_w	= Wet bulb correction factor.
C_h	= Tower height correction factor.
T_1	= Inlet temperature.
T_2	= Outlet temperature.
$(T_1 - T_2)$	= Temperature range.
T_{wb}	= Wet bulb temperature.
$(T_2 - T_{wb})$	= Approach to wet bulb temperature.

Problem No. 1: Determine the length of a 35 ft high tower required to cool 1500 gpm from 90 F to 75 F with a 70 F wet bulb temperature and a 3 mph wind. From these conditions we know that the approach ($T_2 - T_{wb}$)

Fig. 6. Tower height performance factor for atmospheric cooling tower



* In deciding upon a design wind condition, it is well to bear in mind that there is a period occurring during the day and night in which the prevailing wind shifts. When this occurs, there is a short period when there is little or no air movement. During such period, the tower water temperatures will rise from 2 to 5 deg, depending on the duration of the calm and the design wind velocity. This should be evaluated in determining a design wind velocity. However, one should be aware of the fact that many atmospheric towers are designed to operate successfully at a zero wind condition

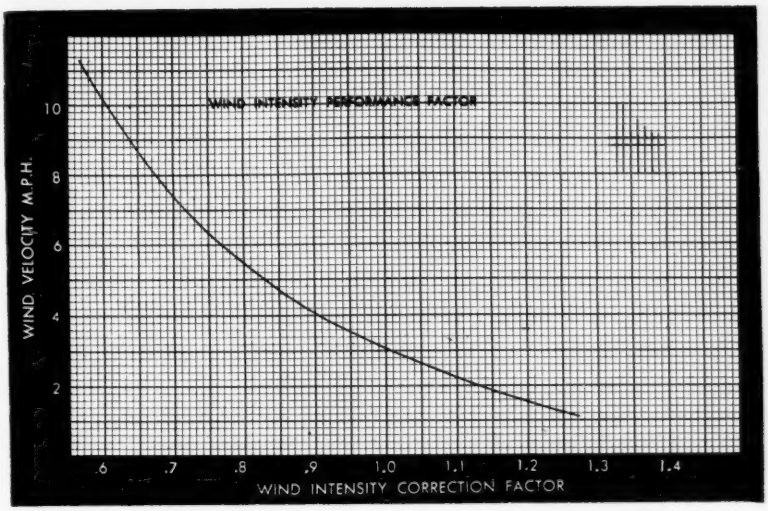


Fig. 7. Wind intensity performance factor for atmospheric cooling tower

= 5 F and the range $(T_1 - T_2) = 15$ F. From Fig. 4, it is found that these two values require a concentration of C = 1.17. The correction factors, C_h, C_w and W will be equal to one, as shown on their respective correction factor curves, because Fig. 4 was based upon values equal to those given in the problem. Substituting the corresponding values in the above formula we find that a tower 107 ft long is required.

Problem No. 2: Let us take the some conditions that exist in Problem No. 1 and see what the effect would be when the wind velocity is increased to 5 mph. From Fig. 7, when the wind velocity is 5 mph, W = 0.80. Substituting this value for W in the formula, we find that an 85.3 ft long tower is required.

Problem No. 3: Again assume the same conditions as in Problem No. 1, except that, due to space considerations, it is necessary to have a 51 ft high tower. From Fig. 6, when tower height is 51 ft, $C_h = 1.63$. Substituting the new C_h in the formula, we find that a 65½ ft long tower is required.

Problem No. 4: Assume that the conditions of this problem are identical with those of Problem No. 1, except that water has to be cooled from 85 F to 70 F and the wet bulb temperature is 65 F. From Fig. 5, when the wet bulb temperature is 65 F, $C_w = 0.86$. Substituting this factor in the general formula we find tower length to be 124 ft.

Problem No. 5: Once a tower is installed, the problem often arises of determining what cold water temperature one can expect under conditions differing from those for which the tower was designed. For example, let us take the tower calculated for Problem No. 1. This tower is 35 ft high, 12 ft wide, and 107 ft long. What cold water temperature, T_2 can be expected when the wet bulb temperature is 60 F, wind velocity 4 mph, cooling range 15 F, and water circulation 2,000 gpm?

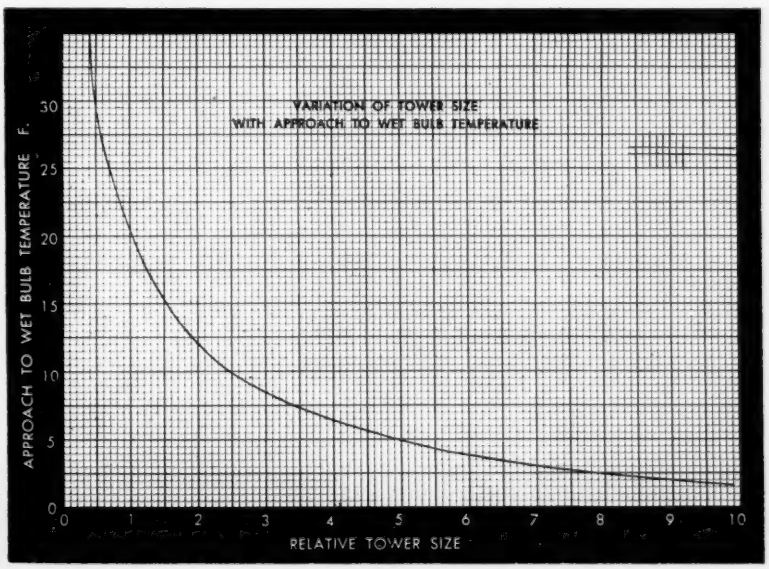
The wet bulb temperature correction factor C_w, from Fig. 5, is 0.71. The wind velocity correction factor W from Fig. 7 is 0.875. By substituting these values in the general formula and solving for water concentration, we find:

$C = (2000 \times 0.875) \div (107 \times 12 \times 0.71 \times 1) = 1.92$ gal per sq ft

Turning to Fig. 4, we find that when the cooling range is 15 F and water concentration is 1.9, the approach to the wet bulb temperature is 9 F. This means that the cold water temperature will be 60 F + 9 F = 69 F.

The general information given is presented solely for the purpose of showing the more important factors that affect the design of atmospheric type cooling towers. Space does not allow consideration of the effect of excessive or insufficient concentration, higher relative humidity, change in wind direction, and other finer points which must be analyzed for proper cooling tower selection. Therefore, it is to be noted that the cooling tower sizes calculated in the above examples are only approximate. This survey, while presenting the essentials, has purposely been kept as nontechnical as possible in order that it may serve as a guide to the plant operator in evaluating cooling tower performance.

Fig. 8. Variation of tower size for variation in approach to wet bulb temperature, atmospheric cooling tower



CONCRETE LININGS IN STEEL STACKS—CORRECTION

IN THE article under the above title, in paragraph 3, column 2, page 118 of the April 1947 issue, the last sentence should read—"Trap-rock has the advantage of being an inexpensive, natural aggregate, but in many parts of the country it is not obtainable." As originally printed the word "inexpensive" appeared as "expensive." It is suggested that you make this correction in your copy.

A RECENTLY developed all-Canadian mica-material will help greatly to conserve the use of muscovite mica, which at present is in extremely short supply, being chiefly imported from India. This statement is made by the manufacturers of the new mica, the Mica Co. of Canada. It is predicted that the new high heat binder plate will permit a reduction in cost and material in the production of toasters and other electrical equipment. The new product is a built-up plate of Canadian amber mice "splittings" bonded with a special heat resistant binder.

Foaming In Boilers can be Economically Controlled

By **W. H. THOMPSON**, Director of Service
and **C. JACKLIN**, Chemical Engineer, National Aluminate Corp.

A major cause of wet steam is the formation of thick foam layer on the boiler water surface . . . Certain polyamides are effective as antifoams for controlling this condition . . . Detailed results of one plant test are presented as an example of the remarkable effectiveness of this treatment

STEAM PLANT operators and executives want to know how to prevent wet steam. As a result, laboratory research and plant experimental work have been carried on by many investigators for a number of years.[1], [2], [3]. A treatment has been developed which solves the problem when the source of wet steam is foam in the boiler.

A continuous layer of foam or unbroken bubbles builds up on the water surface in many boilers. Wet steam results when certain combinations of mechanical, chemical and operating conditions cause the foam layer to build up high enough to be carried out physically by the vapor or to flood the internal baffles so that they do not function correctly.

Certain polyamides were developed as antifoams to control this condition. They are believed to form aggregates on the bubble films which cause high local differences in surface tension and rapid breaking of the bubbles, thus releasing the vapor and permitting dry steam production.

More than 1000 laboratory tests in an experimental boiler operating at 250 psi have been made on these materials. They are far superior to previous antifoam products. The experience gained from several years use of this material in hundreds of power plants and locomotives has further demonstrated its efficiency for controlling foam.

The detailed report of test results in an individual industrial power plant is presented as an example to show the large increase in boiler water dissolved solids concentration permissible without wet steam when a certain polyamide antifoam composition was used.

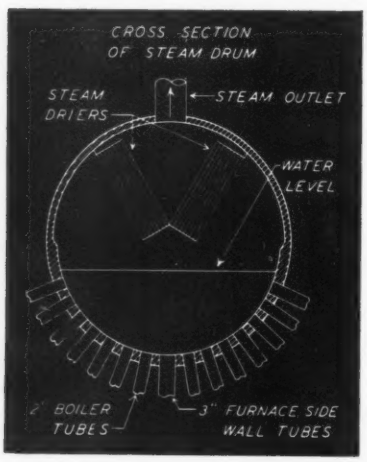


Fig. 1. Cross section of steam drum showing arrangement of drum internals

Boiler

These tests were made on a Type A oil fired boiler operating at 220 psi without superheat. Full load rating was 70,000 lb of steam per hour. Figure 1 shows a cross section of the single steam release drum, 48 in. in diameter and 20 ft long with the normal water level 6 in. below the center line. It is fitted with two, 4-bank chevron type steam driers set in a V position with the point of the V at the center line of the drum. The feedwater discharges through a perforated pipe into the rear one-third of the drum below the water level. All tubes enter this drum below the water level and all steam generated must pass up through the water in the drum before it is released.

Feedwater

Raw water from a polluted source is softened in a hot process lime-soda softener followed by a hot process phosphate softener and filter. Sewage pollution in the raw water supply causes a high ammonia content in the boiler feedwater and condensate. Make-up to the boiler varies from 80 to 100 per cent. Typical treated feedwater analysis in PPM: H—0, P—46, M.O.—77, Cl—68, SO_4—92, SiO_2—7, PO_4—3, DS—260, pH—10.15.

Typical boiler water analysis in PPM: H—0, P—720, M.O.—750, Cl—900, SO_4—1420, PO_4—40, DS—3350, S.S. Trace.

Water Level

The water level regulation on the boiler was very good. Normal water level variation was not more than 1 to 1½ in. Some surging of the water level was observed just before carry-over occurred.

Since there were enough boilers on the line to carry the total load easily, it was possible to set one boiler on manual control at any desired load and maintain it with only slight variations. At 70,000 lb per hr these variations were not over 2,000 or 3,000 lb per hr.

The ASTM steam sampling nozzle is located just after the steam flow orifice in a horizontal run of the steam line about 20 ft from the boiler. From this point the steam sample was carried to the operating floor level in a ½ in. iron pipe.

In order to reduce the gases in the condensate as much as possible, a degassing condenser, Straub and Nelson design, was used. Since the amount of ammonia present in the condensate was relatively large, it was necessary to vent a considerable volume of steam from the condenser to carry off the ammonia. As a result, the degassed sample was concentrated to approximately one-half of its original volume.

The conductivity of the degassed sample was measured and recorded with a Leeds and Northrup conductivity flow cell having a cell constant of 0.1 and a Leeds and Northrup Micromax strip chart recorder reading from 0 to 50 micromhos. A manually operated compensator on the recorder corrected for temperature changes in the sample.

Plant Testing Procedure

The following procedure was used for making these tests. The antifoam composition was dissolved to form a vat solution which was pumped continuously into the feedwater between the filters and the boiler. In each test the antifoam treatment was started at least 6 hr before the start of the test. The boiler was blown down until the dissolved solids were below 3,000 ppm. The steaming rate was set at 70,000 lb per hr and the degasser and recorder were started. After all adjustments were made, a sample of the boiler water was taken and the continuous blowdown line was closed. The time when this line was closed was recorded as the start of the test.

Dissolved solids in the boiler water and ammonia in the degassed condensate were checked every 30 min. Once each

hour phenolphthalein alkalinity, hydrate alkalinity, chloride, and phosphate were determined on the boiler water.

When the recorder indicated a carryover, shown by a large increase in the conductivity, a final boiler water sample was taken. The boiler was then blown down and returned to normal operation without difficulty.

Plant Results

Figures 2, 3, and 4 show the Micromax strip chart records of the steam conductivity during three test runs. The boiler water dissolved solids have been plotted on the same chart to show the relationship between these two factors at all times during the tests. The steam conductivity of 4 to 5 micromhos is composed of a small amount of dissolved gases not removed by the degasser and a very small amount of dissolved solids. No attempt was made to separate these two components. The sudden sharp increase in conductivity indicates that the steam drum internals have been flooded by the foam layer and are not longer able to function efficiently.

Figure 2 shows the record of the control test without antifoam. Carryover occurred when the boiler water dissolved solids reached 3350 ppm. This figure confirmed previous plant operating experience before the use of antifoam was started.

Figures 3 and 4 show the records of comparable tests with 5 ppm and 8 ppm of antifoam added to the feedwater.

The increased boiler water dissolved solids carried in these tests before carryover occurred clearly demonstrates the efficiency of this material for controlling foam.

The quantity of polyamide antifoam compound needed to break the bubbles and control the foam layer varies with the chemical factors present in the water but is usually very small. The treatment cost per thousand pounds of steam produced is usually below one tenth of a cent and frequently as low as one twenty-fifth of a cent.

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[1] Jacoby, A. L. and Thompson, W. H., Proceedings Seventh Annual Water Conference, January, 1947, Engineers Society of Western Pennsylvania.

[2] Place, P. B., Proceedings Seventh Annual Water Conference, January, 1947, Engineers Society of Western Pennsylvania.

[3] Seniff, Proc. Am. Ry. Eng. Assoc. 46 m57-m76 (1945).

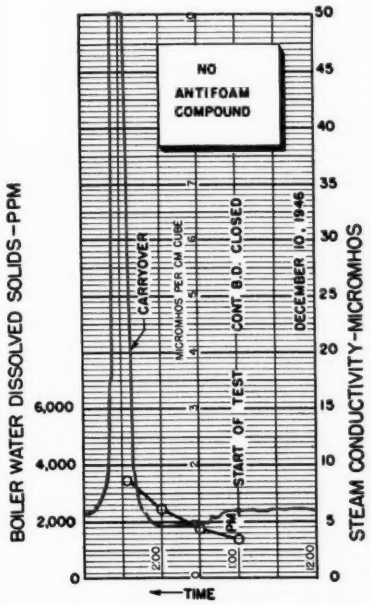


Fig. 2—Left. Strip chart record of steam conductivity with boiler water dissolved solids tests for corresponding time when no antifoam was used. These strip chart records read from right to left.

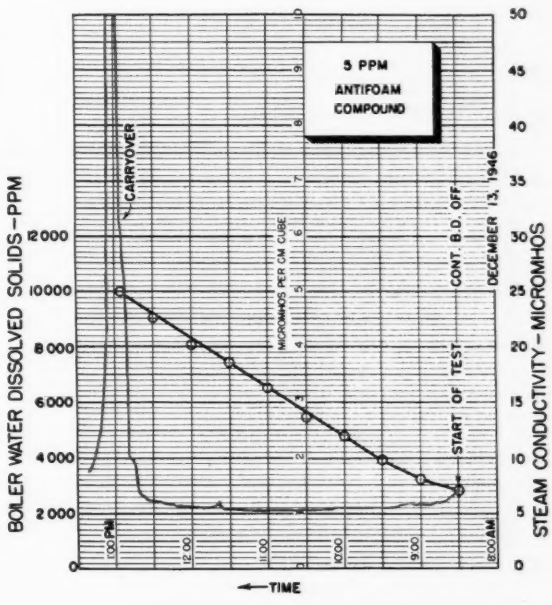
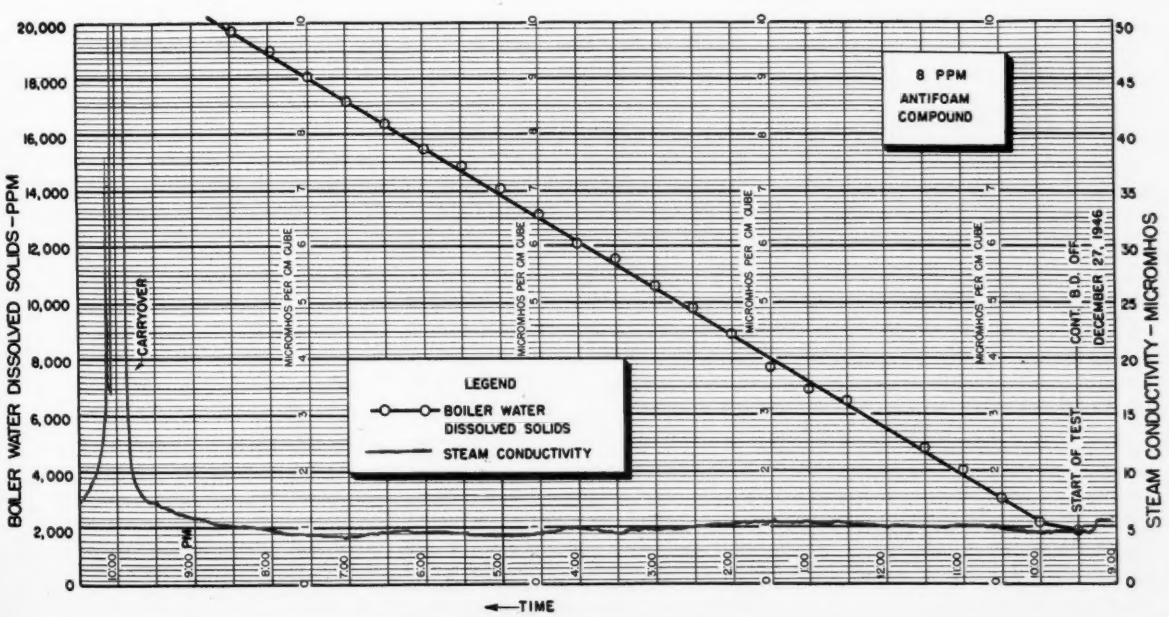


Fig. 3—Right. Strip chart record of steam conductivity with boiler water dissolved solids tests for corresponding time when 5 ppm antifoam was used

Fig. 4—Below. Strip chart record of steam conductivity with boiler water dissolved solids tests for corresponding time when 8 ppm antifoam was used



CRUSHING COAL

(*Continued from page 75*)

quires remarkably little power *, has no parts requiring lubrication or attention, and the rate of feed is readily adjusted while the feeder is operating. Its action is slowed down if the coal should be wet, with many fines, as these tend to stick to the vibrating plate. Usually this is of no consequence, for they loosen up eventually.

Size of breaker Diameter x Length, ft	Approximate tons per hour
7 x 11	45-85
7 x 14	55-100
9 x 11	80-150
9 x 14	100-190
9 x 17	120-230
12 x 11	130-240
12 x 14	160-300
12 x 17	190-360
12 x 19	220-420
12 x 22	250-480

Table IV. Capacities of various sizes of Bradford breaker

Smaller capacities are for hard Pennsylvania "River" coal or Kentucky Elkhorn; the larger values are for Pocahontas and similar coals. Capacities are affected by the hardness and structure of the coal, wet or freezing conditions, size and shape of perforations, control of feed and the like.

When the layout includes the combination of feeder, by-pass, crusher, and a continuous flow type of conveyor or elevator, an unique factor enters. If this conveyor has several open feed points, the entire loading will occur at the first one. The duct fills and no more material can enter so long as this condition holds. We cannot by-pass the undersize into the duct at one point and pass the output from the crusher into the duct at another point, because a momentary surge at the first fills the duct. When by-passing, both discharges must be brought together to a single feed point.

Under certain conditions it may be preferable to locate the crusher aloft, specifically if a skip hoist is contemplated. The average skip with automatic loader and track hopper requires a pit depth of about 20 ft. If we provide a feeder, crusher and surge hopper above the automatic loader, we may require a pit depth of 35 ft, which means going down quite a ways, unless the siding is on a trestle. If the crusher and its feeder are overhead, it means running the skip about 10 ft higher, which may be more convenient. If a Bradford breaker is specified, the feeder may be omitted, as the revolving cylinder serves to distribute the load.

With dry and dusty coal, however, there may be an objection to locating the crusher in an overhead enclosure. The air between the hopper and the conveyor is heavily charged with finely pulverized coal and if a spark should be struck by a fragment of steel, there is the possibility of a dust explosion. While this may be only a local explosion of no great consequence, the "puff" might stir up the accumulations of dust on adjacent members and the expanding ignition may be disastrous.

* 0.5 hp for 50-tph feeder.

Speed* r.p.m.	Max. lump size	Approx.** hp	Approximate capacities ***			
			1 1/4"	1"	3/4"	1/2"
600-720	10	20-25	50-65	45-50	35-40	25-30
600-720	18	30-40	130-140	100-120	80-100	60-70
600-720	24	60-75	225-250	200-235	175-200	125-150
600-720	28	100-125	350-375	330-350	300-325	225-250
600-720	28	150-175	425-450	400-425	350-375	275-300

Table III. Capacities, speeds and horsepower for hammermills

*** 600 rpm for 1½ in. and 1¼ in. products 720 rpm for 1 in. to ½ in. product**
**** For bituminous coals of average hardness**
***** Capacities vary with size of feed, hardness, structure and moisture content of coal**

Whatever type of feeder is specified there must be provision for separated controls so that the crusher can be brought up to speed before the feed starts. Otherwise a large lump may enter when the rolls begin to rotate, causing real trouble.

NEW PYROMETER FOR GAS TURBINE WORK

WITH THE RECENT development of gas turbines and jet engines as practical power plants has come a need for accurate and responsive temperature-sensing instruments. An improved pyrometer for measuring the temperatures of these high-temperature high-velocity gas streams has been developed by Andrew I. Dahl at the National Bureau of Standards in cooperation with the Bureau of Ships, Navy Department.

The new pyrometer consists essentially of an ordinary thermocouple junction around which is pressed a small, light, silver shield. The main problem in measuring the temperature of the hot gases is preventing the transfer of heat to or from the thermocouple junction by radiation. The shields formerly used for this purpose are not only bulky, and slow to respond to changes in temperature, but also offer considerable obstruction to the stream of gas. The use of a silver shield overcomes these limitations since silver, being a good reflector and a poor emitter for radiant heat energy, keeps the temperature of the shielded junction nearly the same as that of the gas.

The new device was found accurate to within 5 F in experiments utilizing a stream of gas at 1500 F flowing with a velocity of 2500 fps through a pipe with walls at 1200 F. In addition to high accuracy, laboratory tests indicate that this pyrometer responds quickly to changes in temperature, is simple to construct and easy to install, and that the new junction creates a minimum of disturbance to gas flow.

Several of the new instruments have been constructed and sent to commercial turbine manufacturers for service tests in full-scale operating turbines.

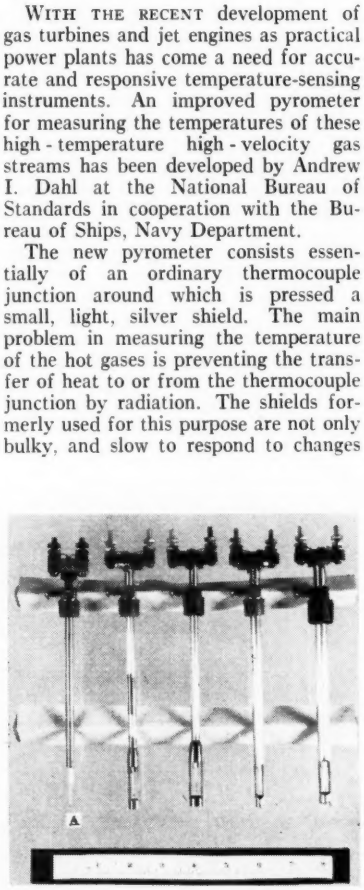


Fig. 1. Five types of steel protected thermocouple pyrometers utilizing silver-shielded junctions developed at the National Bureau of Standards. Guarded junctions give substantially the same results as unguarded type A

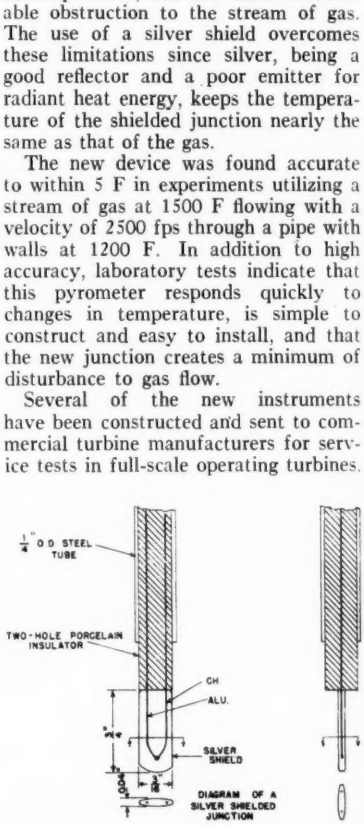


Fig. 2. Schematic diagram of a silver-shielded pyrometer junction of the type developed at the National Bureau of Standards

The junction, made by conventional methods, is inserted ½ in. into a silver tube ¾ in. long that is slightly flattened. A thin mica strip is inserted within the silver tube on each side of the junction and the assembly is pressed to form a rigid unit with good thermal contact between shield and junction. The maximum width of the completed shield need not exceed the diameter of the porcelain tube.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

SOMETHIN' NEW

One element in the manufacture of electrical equipment that has never lent itself to mass production technique is wiring. No matter how well the component parts of an electrical assembly could be stamped out, moulded, die-cast or machined by mass production methods, the wiring always had to be done by hand. During the war, in the manufacture of certain miniature radio assemblies a method of "printed" wiring was developed which proved effective in limited applications but its very nature precluded its use for general application. Now, however, a new method of "stamped" wiring has been developed which seems to offer possibilities in the manufacture of many small electrical equipments. This system, developed by The Franklin Airloop Corporation of New York is described in the June issue of Electronics. Basically, stamped wiring consists of a thin sheet of insulation with a series of parallel conductors running in a horizontal direction on one side and a series of vertical conductors on the other side. Interconnection between the horizontal and vertical conductors is accomplished by punching holes through the insulation intervening between such conductors and then joining them by means of an eyelet or pin. Where connection to a single horizontal or single vertical conductor is required, without interconnection, an eyelet or a pin may be punched in the selected conductor at a point which causes it to miss the metal on the reverse side. Where breakup of a single horizontal or single vertical conductor into several horizontal or vertical conductors is required this may be accomplished by the simple process of cutting the conductors at one or more points along their length or height. So far, the system has been used in the production of small radio receivers but a basic wiring package could be turned out for many kinds of electrical gear.

The younger generation no doubt will accept this development without batting an eye, but to us "old timers" who built regenerative radio receivers in the old "kitchen sink" days with square conductors and spaghetti tubing, it seems wonderful indeed. We never thought we would live to see the day when "wiring" came out of a machine.

A.W.K.

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A Section of Power Plant Engineering Devoted to
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The Modern Diesel Engine

Logical developments and advances in Diesel engine construction . . . Early effort to do away with air compressor . . . Development and exploitation of mechanical fuel injector . . . War pushed output and new practices in Diesels to unprecedented degree . . . Compounding of Diesel Engine with gas turbine . . . . . . Departure from individual cylinder to en-block construction

By JOHN OSTBORG, Assistant Chief Engineer

Superior Engine Division, The National Supply Co.

ALTHOUGH the Diesel engine has come a long way since Rudolph Diesel built the first successful engine in 1897, the art and science of engine design had advanced to such a point at that time that this first engine had an efficiency of 35 per cent. The untiring efforts of thousands of skilled engineers in the intervening years have not added appreciably to the efficiency of the engine, demonstrating thereby the basic soundness of the original concepts. The engine has, however, changed widely in form and has been adapted to a large variety of uses. It has gained greatly in reliability and output so that today it is a dominant internal combustion engine and outstanding prime mover.

Air Injection

The engine was for years built as an air injection engine, that is, air compressed to about 1000 psi was used to inject and atomize the fuel in cylinders where compression was about 500 psi. Air compressed to this pressure, without loss of heat, has a temperature more than adequate to ignite the incoming fuel.

The compressor, however, was an expensive piece of equipment, which presented a maintenance problem and absorbed some power, so efforts were made rather early to do away with it. About 1912 the English had some success with solid injection systems, using for that time extremely high fuel pressures of 5000 psi or over. The simplification and reduced first cost were such that it was not many years before variations of this system were applied almost universally to all Diesel engines except the largest.

The progressive development and exploitation of the mechanical fuel injector forced the advancement of high speed engine design so that this phase of the Diesels' advance was vigorously pushed in the United States in the 1930's. The possibility of increasing the engine horsepower directly with the speed has tended to increase the speeds in all engine sizes progressively, being limited at any one time chiefly by construction materials and application practice.

The supercharging of Diesel engines is not new, but was slow to develop in this country and it was not until shortly the well-known Buchi turbo-charger was being produced by an American manufacturer.

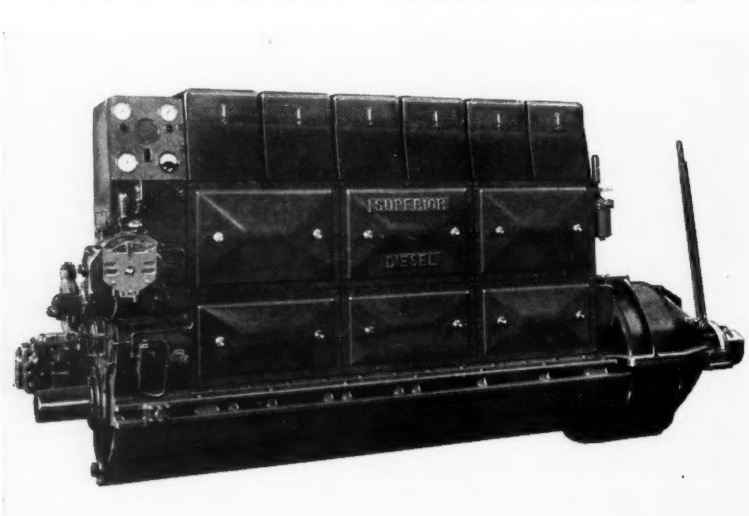


Fig. 1. Marine Diesel of unsupercharged type. This is a 6 cylinder unit developing 260 hp at 600 rpm, 4 cycle

Supercharging Developments

The war made it necessary to push the application of supercharging so that now practically all medium and slow speed engines in the United States are supercharged. This has meant an increase in the usual four cycle bmep. from 75 to 120 psi so that with an accompanying increase in speed, fairly large engines weighing 30-40 lb per hp are not uncommon and in a number of cases such as in locomotive and submarine service this has been reduced to 15-20 lb per hp.

Although four cycle engines of about 6000 hp have been built it seemed some years ago that the economical limit for this type of engine was about 1000 hp. The apparently simple two-cycle engine seemed destined for the larger powers, but it also began to invade the lower horsepower ranges at an alarming rate.

The advent of the turbo-charger has changed the picture radically so that now with higher rotative speeds and high pressure supercharging the top economical limit for four cycle engines can well advance to 2500-3000 hp. Supercharging the two-cycle engine is a more difficult problem, but it is not expected that the four cycle engine will enjoy its apparent advantage for long.

What is in the opinion of some engineers the last phase in the development of the Diesel engine is the compounding of the engine with the gas turbine. Work along this line began in Switzerland during the war and has aroused considerable interest in this country. Compounded with the turbine, the Diesel engine with the aid of a suitable air compressor becomes a gas generator supplying high pressure exhaust gas to a turbine which would then be the prime mover directly connected to a generator or to a propeller through reduction gears. The present usual charging pressure for 120 psi, bmep is about 5 psi, but many builders are working for higher pressures so that engines developing 180 psi, bmep are in the foreseeable future, and as engine bmep's go up it will become a problem as to whether to make the engine or the turbine the prime mover. Experimental engines have been built to operate at 300 psi, bmep and this may be the ultimate development of the engine if the gas turbine continues to increase in efficiency and decrease in cost.

30,000,000 hp in 1944

The first American Diesel was built in 1898. Yearly sales increased steadily until in 1915 we produced 100,000 hp. By 1940 we were producing 3,500.000 hp and in the war year 1944 it has been estimated that we produced about 30,000,000 hp. This, of course, is no indication of our present production which is considerably lower than this. The Diesel engine had become so important that by 1945 a large part of the Navy's power afloat, over 30,000,000 hp was Diesel. This represents considerable in-

crease over the 150,000 Diesel horsepower used by the Navy during World War I.

Today, Diesel engines are built to run on the four stroke or two stroke cycles, single acting, double acting, or, as opposed piston types; in combinations of cylinders from 1 to 16 as in-line, radial or V-type engines. Speeds range from 75 to over 3000 rpm and horsepower ratings from about 5 to over 24,000, but the vast majority of engines built in this country are under 2,000 hp.

Diesels are widely used as prime movers for stationary applications and in generator sets as service or standby units. The engine invaded the marine field at an early stage and has made heavy inroads into the traditional steam engine on the high seas, and has taken over in coastal and inland waterways service to such an extent that about 65 per cent of the work boats on our rivers are Diesels, with steam fast dying out. In submarines the Diesel enjoys a unique position in being apparently the only engine suited to the service.

In the automotive field the engine advanced with its development so that it has become established as the locomotive switching engine and has become a very serious competitor to steam for main-line passenger and freight service. The rail car field is preempted by the high-speed Diesel, the smaller models of which are also widely used on trucks and busses where the service is of such a nature that fairly high initial cost is counter-balanced by engine operating economies.

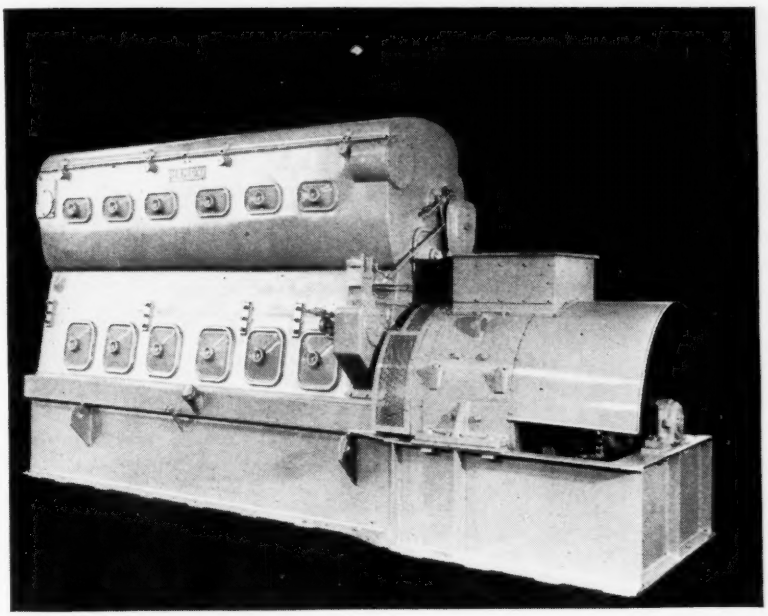


Fig. 2. This unsupercharged Diesel is a 6 cylinder, 12 by 15 unit developing 600 hp at 600 rpm

Blocks and Bedplates

With the departure from the individual cylinder tradition to the en-block construction as used today the Diesel tended before the advent of the turbocharger to be made by designers to resemble a smooth power block in which such accessories as manifolds, pumps, filters and coolers were made to fit the general desired outline as much as possible. This sometimes made for lack of flexibility in applying the engines to various conditions. The coming of the turbo-charger, however, upset all the neat arrangements. Manifolds have become more apparent and the turbocharger does not lend itself very well to being blended into preconceived lines. There are special purpose engines being built, but most engines are built for several speed and service requirements as well as considerable variation in horsepower ratings so that considerable flexibility in the arrangement of auxiliaries and attachments may be necessary, so that the sleekness of exterior desired some years ago has undergone modifications. The idea of the power block is not neglected but modified by the need for flexibility, with each attachment and auxiliary to the main unit being designed to seem an integral part of the whole.

The usual material for blocks and bedplates today is the traditional cast iron, but of somewhat improved quality. A few builders have gone to welded steel because of service requirements or the availability of mass production welding machinery. Weldments, when frankly treated as such, can be given a very pleasing appearance, and when properly designed can be just as rigid and stronger than cast iron. Modern techniques have tended to reduce costs so that in some cases weldments are competitive to iron castings, but at present, cast iron blocks and bedplates predominate in the industry.

The crankshaft represents an item of considerable cost in an engine and in the smaller engines which use drop forged cranks, the cost has been reduced to a possibly irreducible minimum. The larger cranks on the other hand have to be forged under a hammer and machined all over with a considerable portion of the material being removed in the process. During the war some crankshafts were made for a large two-cycle engine which were built up of individual die forgings of the crankweb with half the crankpin and journal protruding. The forgings were welded together at the cranks and journals with also whatever shaft extension needed at each end; requiring a minimum of machining for completion. The process was thought too costly for peace-time competition, but with the reduction of welding cost it is thought that the price can be made attractive to engine builders.

Good bearings contribute greatly to trouble-free operation, and with specialization in large bearing manufacture, we have bearings which make it possible to have almost factory perfect bearings for the life of the engine. The better bearings today have only a few thousandths babbitt on about one thirty-second bronze on a steel back and require little or no scraping and fitting if the seats are perfectly made. The bearings will run for years with no take-up or replacement being required. In fact, they can't be taken up because bearings today are assembled with no shims between the shells. Continual improvement in bearings plus improved breathing capacity due to better valve gear and scavenging methods have contributed to a constant increase in rotative speeds. We have not yet come to the end of this development, but it is recognized that speeds can't be increased forever. As an example of speed increase, a four cycle 12½ in. by 15 in. engine designed to run at 400 rpm some years ago, was later redesigned and has operated very successfully as a locomotive engine at 660 rpm and for continuous service, one would have no qualms about offering it for 514 rpm.

As engine speeds go up, higher speed engines are beginning to invade the field previously allotted to the slower speed engines. This is made possible by driving through reduction gears which have gained greatly in favor as they have been progressively improved. The use of a reverse and reduction gear with a suitable clutch makes it possible to use a high speed, mass production, low cost, variable speed stationary type engine as a marine engine for slow turning propellers where the large slow speed engine was at one time thought to be supreme.

Many interesting features have contributed to the reputation of the Diesel engine as a prime mover, but the greatest of these is supercharging. This can be appreciated when it is considered that supercharging will increase the horsepower of a four-cycle heavy duty engine 60 per cent at present day rat-

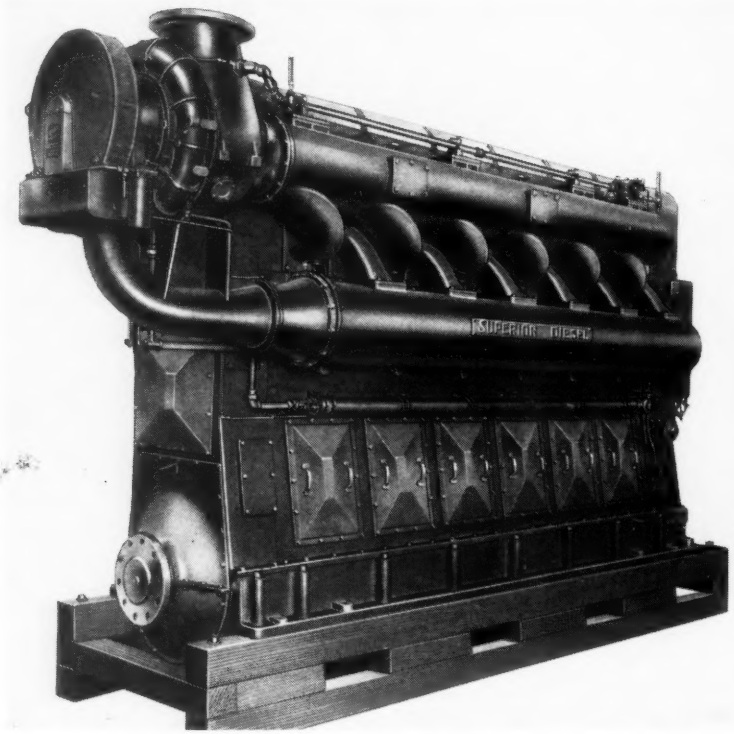


Fig. 3. Marine Diesel which develops 1080 hp at 360 rpm. This is a supercharged unit (Note how much more apparent are the manifolds in a supercharged unit)

ings. This increase is made possible without increasing the physical space required by the engine, thus increasing its usefulness enormously as a prime mover for all types of installations.

The use of supercharged engines is increasing rapidly and it looks as though all medium size and large engines will be sold as supercharged engines in the near future. Indeed, it can be expected that supercharging will be applied quite generally to the high speed engines too, as chargers are made available.

The development of supercharging forced the development of oil cooled pistons and since the results were very beneficial and the problems involved not too difficult, most manufacturers have provided oil cooled pistons for all their engine sizes. Since oil cooling permitted the cooler running of piston rings, one of the most critical items in an engine, it was thus permissible to raise the ratings of normally aspirated four cycle engines from 75 psi to 80-85 psi, bmep, thus decreasing the weight to horsepower ratio and adding further to the reliability of the engines.

Helixhaust Manifold

The early exhaust manifold used with Buchi turbochargers were lagged individual pipes connecting two or three cylinders to the turbine nozzle box; but this arrangement had several disadvantages. The heat given off to the engine room was often oppressively excessive and the exhaust system was cumbersome to handle when the engine was serviced. Manufacturers have solved this problem in their own ways, but one of the most interesting, which enjoys widespread use, is the Helixhaust manifold. This manifold is no larger than and looks very much like a conventional manifold. In addition it is water cooled, thus minimizing the heat transfer to the engine room. The inside of the manifold is so arranged that, by means of helixes, the manifold is divided into the number of cylinders divided by two compartments. Two cylinders exhaust into each compartment 360 F crankshaft travel apart, making sure there will be no blow-back of exhaust gases.

The Diesel engine has gone through hundreds of variations and of these, probably only the earliest or air injection engines could be called true Diesels. Air injection is now used only on the very largest engines with the vast majority of engines using mechanical injection of some kind. The term Diesel now covers all engines in which the compression temperatures is high enough to ignite the fuel as it is sprayed into the combustion chamber. Oil engine and compression ignition engine are also terms which have had some vogue. The early engines started out as simple power plants, but as engine speeds increased, the power plant became complicated by the addition of reduction gears, reverse gears, clutches and couplings of all kinds. Ultimate output from the engine means compounding with the gas turbine which should give a high overall efficiency. Compounding, however, means further complication of the power plant insofar as a compressor must be added to furnish high pressure air to the engine to permit its working at an elevated atmosphere. The turbine must now be somewhat larger than the supercharger and can be used to drive the compressor or be the prime mover. If used as the prime mover, the engine will drive the compressor while the turbine will be connected to a generator or provide power through reduction gears to a propeller or whatever may be desired.

The power plant will by then have acquired so much machinery that the engine will be only a fraction of the weight of the whole thereby decreasing its relative weight importance and also probably making it only an academic question as to whether one should use a four or two stroke cycle engine. The one thing one can be sure of is that in this mass of machinery the choice of engine will be based on simplicity and reliability.

FUNCTION OF STEAM SEPARATORS

By E. J. GLINSKE, Cochrane Corp.

STEAM from boilers is rarely dry, particularly under forced loads. This entrained moisture may cut turbine buckets like a sand blast or damage other steam-using equipment. In some other applications, additional contamination is introduced. Exhaust from a reciprocating engine, for instance, contains microscopic particles of cylinder lubricating oil.

Line Separators

Line-type separators, or line separators, are non-receiver type separators used generally under conditions where the steam has steady, uniform moisture content and no pulsating or fluctuating characteristics.

Receiver Separators

Receiver type separators, or receiver separators, are so called because of the large well or receiver which serves both as a momentary storage chamber for the water removed from the steam and as a damping chamber to equalize the flow through the steam pipe. The storage capacity of the large well or receiver is important not so much with

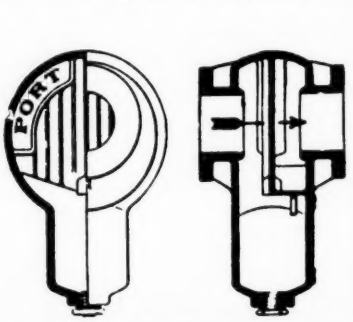


Fig. 1. Horizontal line separator with section at left showing port around central ribbed baffle

respect to its momentary water storage —for most receiver separators are designed to handle low moisture content steam only and not slugs of water—but rather with respect to the large volume of steam it will hold.

The effect of installing a receiver separator in the supply steam line of a reciprocating engine is to maintain a higher average pressure in the valve chest during the period when admission valves are open, enabling the engine to deliver a greater amount of work per pound of steam consumed. Placed close to the throttle of the engine, the receiver separator will cause the steam to flow uniformly through the steam main, the receiver capacity acting as a cushion or spring to take up inequalities—such as intermittent drafts of steam by the engine or any tendency to pulsation or vibration—due to the engine.

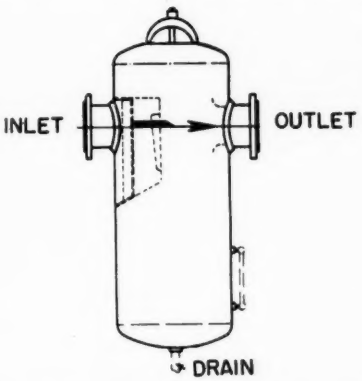


Fig. 2. Receiver-type separator for horizontal lines provides additional storage and minimizes pressure fluctuations

Purifier-Type Separators

Purifier type separators, or steam purifiers, possess all the advantages of receiver separators, and many more in addition. The steam purifier has two separating compartments, each with a separate drain, and an outlet compartment separately drained, all of which compartments are completely closed off from each other.

In the first compartment of the steam purifier any slug of water in the steam is knocked-down by means of a slant baffle located just after the inlet nozzle and immediately diverted to the extra large separate drain pipe. The steam, which may have entered the purifier at high velocity, is redirected through a second nozzle, similar to but much larger than the first or inlet nozzle, which slows down the steam to proper velocity before it enters the second compartment. In the second compartment, the steam impinges against a specially designed baffle, ribbed, closed top and bottom, self-cleaning, very efficient and with more than ample port area on each side to keep pressure drop to the very minimum, after which it passes to the outlet compartment and to point of use.

All three drain legs of the steam purifier are tied-in to one common drain line to trap.

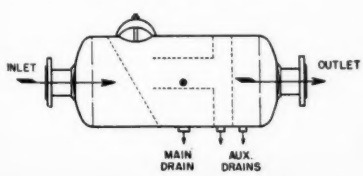


Fig. 3. Purifier-type separator with three separation compartments provides thorough removal of moisture and solids. It is adaptable to special applications

Design Features

The receiver separator and the line type separator having only one single baffle or separating compartment located just after the inlet nozzle, and a single drain, are not nearly as well equipped to handle heavy surges or slugs of water, some of which might readily get by the close-up single baffle or first separating compartment, as the steam purifier. Thus, the steam purifier possesses greater efficiency characteristics for the removal of moisture and solids, and for enabling the amount of lubricating oil used in an engine to be reduced. Also, it is invaluable wherever the conditions of operation fluctuate widely in short intervals of time. Too, the steam purifier is "flexible" in that it can be fitted with connections of the same size as the existing pipe line, whereas in most cases the size of the inlet of the receiver separator and line separator is "fixed" at a larger size than the existing pipe line in order to afford proper velocity at the separator inlet.

This feature alone, in addition to better efficiency, sometimes makes the steam purifier more advantageous initially, especially in exhaust steam, oil removal service. In this latter service the steam purifier is readily adaptable to incorporation of water sprays should the steam be slightly superheated or need extra moisture content to accomplish separation, and a steel wool compartment should the oil used be compounded or waxy and extremely difficult to remove.

"Are these some of the money saving schemes of our new accountant?"

Practical Applications of the Mollier Diagram—I

By WALTER HEIDECKER

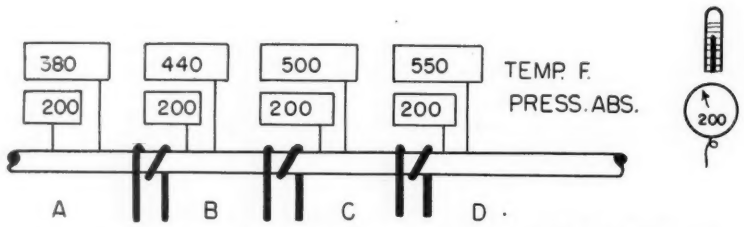


Fig. 1. Diagram of an apparatus consisting of a steam pipe fitted with heating coils

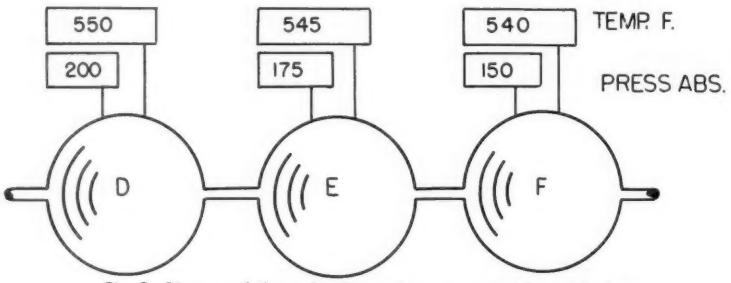


Fig. 2. Diagram of three closed containers connected by small pipes

IN HIS very fine article in the December, 1946 issue, "How to Use the Mollier Diagram," Jacob Yavitch explained how the diagram is a ready and rapid aid in solving problems involving the properties of steam. Although the accuracy with which the diagram can be read is not always sufficient for the most precise engineering calculations, nevertheless it can be used effectively in practical work by the operator of steam equipment for checking the approximate steam conditions.

When "steady flow" conditions prevail in the water cycle, it is possible to check on the diagram the efficiency of any unit of equipment on the system. To locate any point above the saturation line, all that is required is the pressure and the temperature, both of which can be obtained from gages. Locating a series of points on the diagram corresponding to the steam conditions as the steam passes through a heater or turbine, then connecting these points with a line, will give us what we shall call the "condition line" of the steam as it passes through the machine.

To assist the reader in locating points on the Mollier diagram, we suggest that a blue line be drawn over the pressure lines 100 lb apart, and a red line be drawn over the temperature lines 40 F apart.

The various units of equipment in a power plant have characteristic "condition lines" on the diagram; joining these lines together, we get a picture of the condition of the steam and water around the cycle.

When heat is added to steam in a closed heater (superheater), at a constant pressure, the condition line is drawn upward to the right, indicating an increase in heat content, but follow-

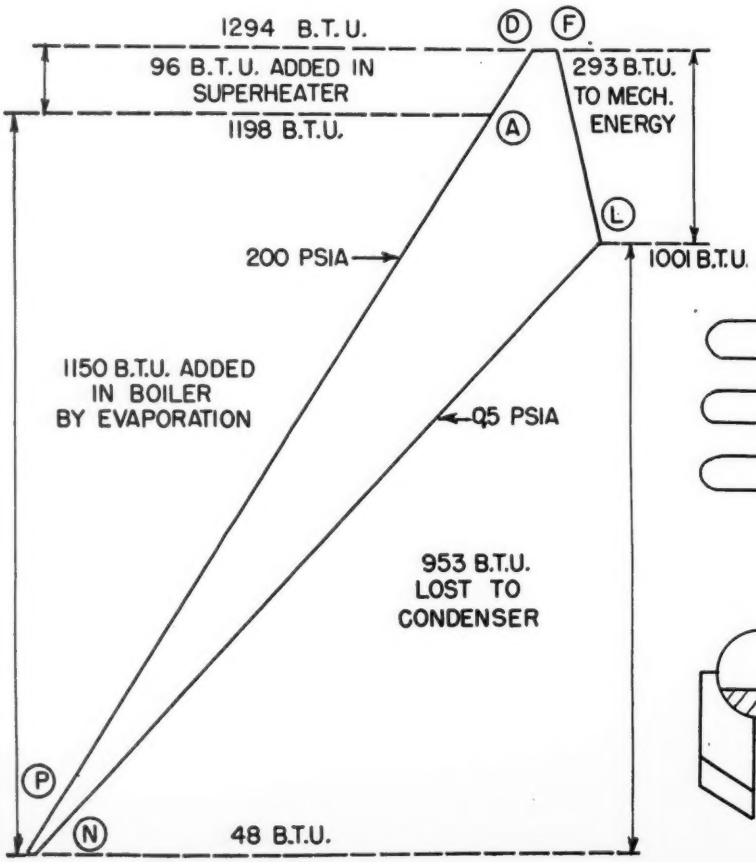
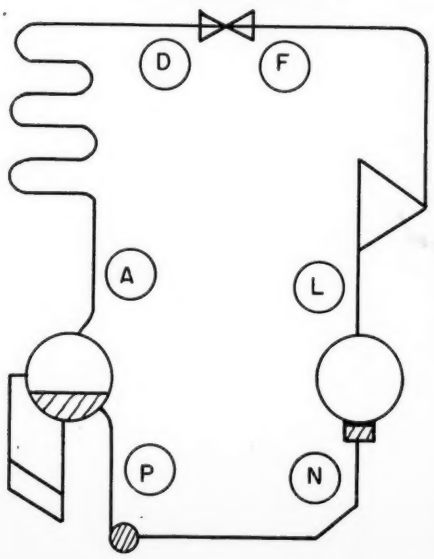


Fig. 3—Left. Diagram illustrating the distribution of heat

Fig. 4—Below. Steam power plant operating on the Rankine cycle



ing the pressure line. Figure 1 is a diagram of an apparatus consisting of a steam pipe fitted with heating coils. Pressure and temperature gages are placed at regular intervals. Steam enters at A and is heated as it flows through pipe to D. Read the gages and locate the points on the Mollier Diagram Fig. 5. Connect points A, B, C and D with a line. This is the characteristic condition line of a closed heater

Reversing the flow of the steam in the pipe (flowing from D to A) and having the coils filled with cooling medium, heat is removed at a constant pressure. This time the line is drawn downward to the left (D to A), indicating the removal of heat at a constant pressure. This line also represents the condition line of condensing in a surface condenser. The lower point of the line is located as the intersection of the pressure line and the heat content line of the liquid. At low pressures this equals the temperature of the liquid minus 32. The upper end of this line is the intersection of the condenser pressure line and the condition line of the turbine or engine.

Evaporation of feedwater in a boiler at a constant pressure is the reverse of condensing. The upper point of this line is the intersection of the pressure line and the saturation line. The lower point is the intersection of the pressure line and the heat content line of the feedwater. The heat content of feedwater is taken from the saturation temperature table using the temperature of the feedwater and taking the heat of the liquid at this saturation temperature as the heat contained in the feedwater.

When mechanical energy is transformed into pressure of a liquid (boiler feed pumps), the condition line of the feedwater is drawn horizontally from right to left. The pressure increased but the temperature and heat content remained the same. When kinetic energy is dissipated by means of an "engineered obstruction" (throttle valve of a turbine), it is represented on the Mollier Diagram by a horizontal line drawn from left to right. To illustrate this wasteful operation see Fig. 2 which is a diagram representing three closed containers connected by small pipes and having temperature and pressure gages at regular intervals. Read gages and locate points on the Mollier diagram Fig. 5 (D—E—F).

When heat is transformed into mechanical energy (turbine or engine), the condition line is drawn downward to the left, indicating a decrease in heat content and a drop in pressure. To illustrate this complicated process, Fig. 6 is a diagram of a steam turbine having 6 sets of nozzles and 6 wheels of blading, with pressure and temperature gages at regular intervals. Admitting steam at F and exhausting at L the turbine shaft revolves driving the generator which has an electrical load. Read the gages at F, G and H and locate these points to the saturation line. As I, J, K and L fall below the saturation line they cannot be located by intersection of pressure and temperature. To find point L, extend the line F, G, H until it crosses the exhaust pressure line at M. Most authorities agree that a turbine is only 90 per cent as efficient in the wet region, the 10 per cent loss being passed on to the condenser as reheat. An allowance of 10 per cent (1150 — 985 = 165 × 10% = 16.5) is added to the total heat of the steam entering the condenser (985 + 16 = 1001 Btu). Where the 1001 Btu line crosses the 0.5 lb abs. pressure line is the end point L of the condition line of the turbine. Connect L to the F, G, H, line. F, G,

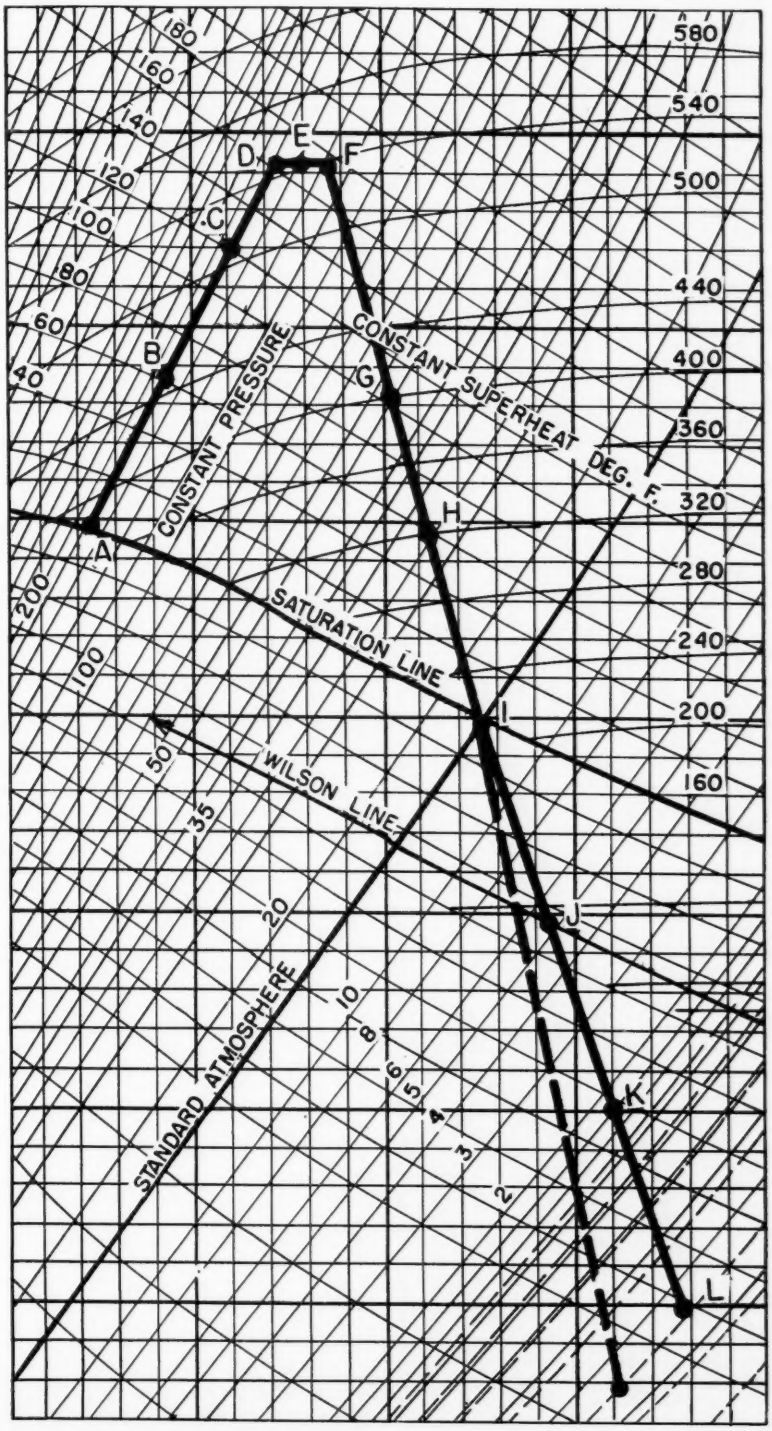


Fig. 5. A section of the Mollier Diagram

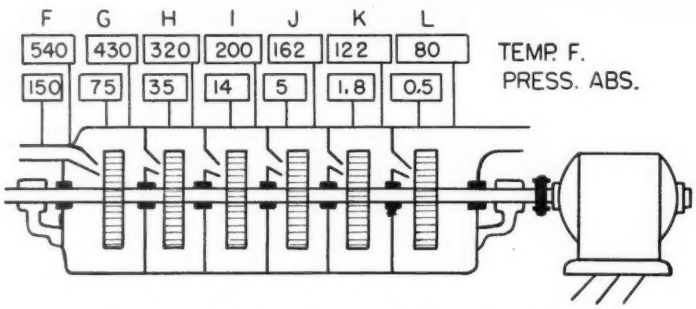


Fig. 6. Diagram of a steam turbine with six nozzles and six wheels

H, L is the condition line of the turbine. This will vary constantly with the load the generator is carrying.

"N" is the end point of the condensing line, see Fig. 3. This is the intersection of the 0.5 lb pressure line and the heat of the liquid (80 — 32 = 48 Btu) line. Point P, the beginning of the evaporation line, is the intersection of the 48 Btu line and the 200 lb pressure line. Connecting all these points with a continuous line Fig. 3, gives us the characteristic diagram of a power plant Fig. 6, operating on the Rankine cycle.

FOR THE PLANT ELECTRICIAN

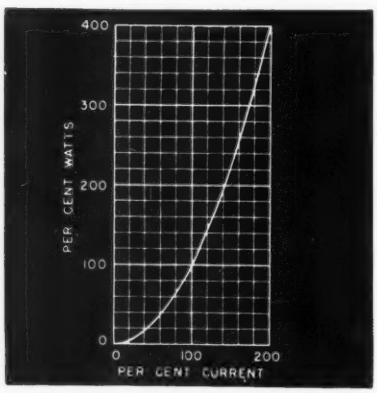
WATTAGE AND CURRENT RELATION IN RESISTORS

THE SELECTION of a resistor for a specific application requires a knowledge of not only the resistance required but also the wattage to be dissipated, as the physical size of the resistor will be largely determined by the latter factor. Another point of importance is the degree of ventilation, as the nominal wattage ratings are based on free air mounting of the resistor.

The wattage to be dissipated in the resistor can be calculated readily by means of Ohm's Law when the resistance and current (or voltage directly across the resistance) are known. It is important to note that the wattage dissipated in a resistor varies as the square of the current, as stated in the equation: $W = I^2 R$

W = Watts
I = Current in amperes
R = Resistance in ohms

Non-technically stated this means that any change in the current causes a much greater change in the wattage, as graphically illustrated above. Thus, if the current is doubled, the wattage is multiplied by $(2)^2$ or 4; if the current is tripled, the wattage is multiplied by $(3)^2$ or 9. The importance of small changes in current is often over-looked, but it should be realized that if the current is increased by only 10 per cent, the wattage is increased by 2 per cent; and if the current is increased 20 per cent, the wattage is increased 44 per cent. Hence, the actual current must be used in figuring the wattage, and the increase in wattage due to apparently small changes determined, in order to select the proper size resistor.



Graph showing relation between current and wattage

RECONNECTING MOTORS FOR DIFFERENT VOLTAGES

I DESIRE to comment on C. C. Hermann's article, "Reconnecting Motors for Different Voltages" which appeared on page 99 of the December 1946 issue. These comments are made in the spirit to enlighten POWER PLANT ENGINEERING readers and not just to be critical.

A three phase, 220-v delta connected motor, re-connected to star, either with 6 leads as indicated in Fig. 1, or with 3 leads brought out as in Fig. 5 is not effectively nor efficiently adaptable for 440-v service lines and simple mathematics will prove this.

Star Voltage = Delta voltage × √3
or 220 volts × 1.73 = 380 volts

not 440 v as stated by Mr. Hermann.

If we compare coil emfs and coil currents we can easily visualize the detrimental effect of such a star connected motor operated on 440 v service. It is more advantageous to use a step-down transformer and not waste the time and money in re-connecting a delta connected motor to star and expect good performance. The chances are that someone may mourn the loss of a complete stator winding.

The parallel star shown in Fig. 2 and the series star in Fig. 3 is proper for a 2 to 1 voltage changes (220-440) except that is is advantageous to bring the nine leads out (instead of three). This would simplify 220 v-440 v changes or vise versa without removing the end shields and uncovering the winding.

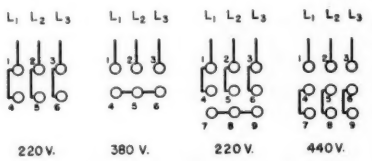


Diagram showing reconnections for various voltages

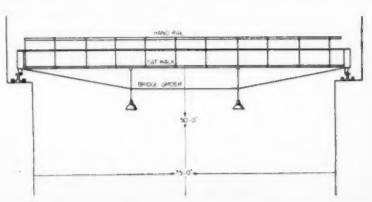
The accompanying sketch should help and simplify in understanding the connections.

Astoria, L.I., N.Y CARL BACHMANN

AUXILIARY LIGHTING ON BRIDGE CRANE

By Paul C. Ziemke

A NEAR FATAL accident that occurred as a result of insufficient light in making an important hitch brought up an interesting problem to the electrical department and its engineers. The catwalk of this crane had shut out so much of the light from the 1500 watt lighting fixture that hung from the roof beams that means had to be devised to provide auxiliary lighting to supplement any blanked-out light that occurred as the bulk of the crane girder, carriage or catwalk moved into line. The crane was powered by 3 phase 460 v, A-C power which did not lend itself to lighting purposes with out a step-down transformer to reduce the potential to the conventional 115 v. A check on a disused series of small Jefferson transformers that were once used to furnish lighting current on machine shop units brought one to light that would serve



Two 1000-watt lighting fixtures suspended from cat walk of bridge crane

our purpose nicely. It was mounted in the crane cab "behind" a fused disconnect switch wired into the primary side. The secondary leads were run in conduit to two boxes mounted under the outer edge of the catwalk at spacings to flood the floor below with ample light. Two 1000 watt light fixtures were securely attached to 8 ft of service cord and this cord was threaded through the cover of the 4-in. box. Service cord was selected in place of conduit for two reasons. Conduit would have transmitted too severe a series of vibrations to the lamp filament from the body of the crane as it rolled over the rough track. And, secondly the cord made it possible to haul up the lamp fixture with ease for cleaning or relamping.

In addition to supplying power for the auxiliary lamps the transformer supplies power for an 18-in. oscillating fan for the summer time comfort of the operator working close up under the sunbaked roof.

SLIP RING TROUBLES

FOR A NUMBER of years we were operating our turbines without any slip ring troubles, when for no good reason one of our turbines decided to give us this type of trouble.

The brushes would arc and when the machine was shut down over the week end, there would be a gray discoloration on the highly polished slip ring surface. We would remove the brushes and sand the slip rings so that they would be bright again.

After another week of operations we would have the same trouble only it would be a little worse. As time went on we had to shut down every two weeks. Due to business pressure this slip ring condition got so that we could not remove the discoloration by the application of sand paper and elbow grease. Not only would the discoloration persist but the rings would show minute pits in the metal. This condition got so bad that we had to make up a jig with an abrasive stone and stone the rings so as to remove this pitting.

It perplexed us no end. The load and voltage remained about normal. No matter who paid us a visit at the plant we immediately would ask them what could be done to prevent this condition.

We asked insurance engineers, service engineers, and electricians. Each person had a different suggestion. We were advised to reverse the polarity which we did and the same condition prevailed. Others advised us to remove the brushes when the machine was not operating so as to prevent any electrolytic action of brush on iron ring. Some advised us to change the brushes.

After stoning the slip rings we decided to do a little more experimenting with brushes. We ordered another make of brush, a little bit harder than the ones we were using. After installing these brushes and running a week the slip rings showed a black film of carbon on them, which we cleaned off. After making a thorough inspection we decided that to use the harder brush all around was not the right answer. We removed every other brush and replaced them with a softer brush that we had been using before. There were four brushes on each slip ring, we alternated the brushes so that every other brush would be the harder brush. We polished up the slip rings again and this time we chamferred the edge of each brush with a file. After a two week run the condition of the slip ring was such that the brush combination seemed to be working out. It took a longer time to get this discoloration on the slip ring. Although this was a slight improvement over the other method, we still were not satisfied.

I wrote to another brush manufacturer and they sent out one of their service engineers.

We got into a huddle and after telling him our story he asked to see the brushes. We showed him what we had. After making measurements he discovered that the brushes were undersized. In spite of the fact that the size of brush was ordered correctly the brushes were not the full size all around.

They were not setting in the holder snugly. Another thing we found out that the banding that was used on them was not the proper kind. His company recommended using one of their special brushes for that type of speed machine. We immediately placed an order on a trial basis for a complete new set.

After polishing up the slip rings and fitting in the brushes according to instructions, we started up again a little skeptical that they would do the trick because these new brushes were unusually soft. You could write your name with them on any grade of paper. After the machine was put on the line we watched the performance of the brushes daily. They did not arc and after a two week run the slip rings were the same as when we started up. It has now been 3 months since these brushes have been in service and our trouble seems to be over as far as slip rings are concerned.

Ridgefield, N.J. JOHN F. SLAVINSKY

Misguided Research in Electronics

This letter from one of our readers shows you how not to apply science. It is a heartbreaking account of a project that was doomed to failure from the beginning because of the shortcomings of the brain in which the idea originated. We print it here as a warning to others, who, like Casey, might try to monkey with the electron. In other words, let this be a lesson to you. Any resemblance in this artitcle to persons, places, gadgets and methods are purely incidental. We accept no responsibility for it, in fact, we wash our hands of the whole thing

Mr. Editor:

ON ACCOUNT of how we have the UN now and got to be diplomatic and not hurt the feelings of our allies and enemies or anyone else this salutation has been very bad for me. Last week I would have started *!!**! Editor. Dear Editor would show that I'm very friendly with you which is not so but not as mad as last week.

You in your innocence did not know that last week St. Peter had his sandals all polished up and was wearing cast iron soles all ready to kick you out of the pearly gates when you showed up. You don't deserve to know this but maybe if you know what a close call you had it will learn you to be more careful of what you print in your magazine.

Nicky, says the Boss feeling good last week, we need a new whatyoucallet. Indubitably says I we've needed one for some time. I knew you'd mention it soon, because the Boss likes to think he's pretty good otherwise he would not call me Nicky.

Anyway I'm wondering what the whatyoucallet is this time that being the Boss's little joke. Being busy all day shuffling moneybags and hobnobbing with bankers he feels he should have a vast ignorance of technical terms which he hasn't because he is pretty sharp. All he ever mentions is gadget or gimmick or thingamajig so that we spend about 10 per cent of our time working and 90 per cent figuring out what he is talking about. He says that is all right too in-as-much as he pays the salary and got to have somebody fill in the details of his broader economic planning.

Yes, says he I've been intending to mention it for some time but this time we will get one so that Sol will have no more alibis. Then I know he means a new hydraulic press, Sol being walking delegate without title but with lots of authority who has been playing around with some new plastic business; He takes some molasses and sawdust with some other things and mixes it up adds some mustard, a slice of ham, leaf of

lettuce and presses it all out and bakes it. Then it is good for anything from razor blades to baby pants or with the left overs you grind it up for breakfast food.

Well, says I, we will get started on this right away and the Boss goes about his business, What, says I to myself, are we thinking of hydraulic presses for in this modern age of nuclear energy, the thing to do is give a whirl to this new press I was just looking at on page 100 (Fig. 2) in the March 1947 issue of POWER PLANT ENGINEERING. So I carefully go through all the ads with never a mention of the new press. Ah! says I looking at the picture again, the Editor got up before breakfast and is giving us a bit on the shape of things to come and it got into press before any of the big business moguls have anything on the market. Therefore I will design one of my own. All of which proved very intrikit, on account of how I did not need such a big one as you show. I figured 30 tons was about right but got tangled up with all the zeros and compromised on an even 32, which is almost as bad because I don't know how much 25 zeros after 32 really means. It seems evident however that I don't need two whole grams of electrons, in fact maybe a few would answer the purpose.

Somewhere I read that if one of these here atoms which had cornered the electron market were enlarged to the size of a bunch of grapes and then all the atoms in a water glass or something and maybe if water were enlarged the same way they would fill a cathedral, or the earth or maybe the universe. All this complicated figuring leads me to believe that maybe just two small sized electrons might answer the purpose in as much as these electrons don't seem to like to be near each other. I figure that if I put these little electrons in two cans and put one can in the base of the press, then all I have to do is hire a small boy, like James Watt to push the other can around at the right time to press Sol's sandwich just as hard as he wants. If one electron isn't enough two certainly will be. Of course so far I have not figured how even a big boy is going to shove hard enough to get the second can where it should go. However in scientific investigations of this kind it is well to isolate the various problems and set about solving them individually and not clutter up your mind doing a lot of things at the same time.

Fig. 1. The Prof's cloud chamber was not working

The sealing wax and flannel idea (see P.P.E., March 1947) seemed a good start but awful hard to find so I finally had to cut up one of the wifes old flannel nightgowns which she didn't need now summer is here only she did not feel that way at all when she discovered it. Some people have no interest in science or progress. So I wear the sealing wax almost away and find no electrons. Some of the threads do stick out straight but flop right back when I touch them. So I figure sealing wax electrons are either very weak or else maybe I'm rubbing off only a few corners.

To properly carry on my research what I need is a few good husky electrons which maybe they have down at the university. On a big deal of this kind I have to be a bit cagey and not tell too much but I guess the prof was smart enough to dig it out bit by bit because after a while he just talks big words trying to confuse me and won't even show me an electron although a little box he says counts them bangs away every once in a while.[1] Finally he says the only place you can see them is in his cloud chamber which is not working.[2] However he gives me a picture of one and it looks to be about like a pin scratch. Where I says do you get these things. The rare earths says he is a very effective source for scientific investigations. What are they says I, and he points out my luminous wrist watch dial which is a relic of the last war and don't shine so well anymore but keeps good time. However says he fission, popularily called breaking the atom is best accomplished by relatively slow speed bombardment.

Being quick on the trigger and also being an old artilleryman I get an idea and pull out quick.

If you got to bombard rare earth slow like to get a good husky electron I got just the ticket. On the way home I stop at the plant and tell the boys to dig me a nice pit over on the side hill. Then I go home and dig out grandpappy's old 30-20. It throws a big slug so slow that a good fast jackrabbit can run along side and lick grease off the lead if the jackrabbit were interested in licking off grease. Just to be sure that is not too fast for an electron I take half the powder out of the cartridge.

I wait at the plant until almost dark. At the pit I get cold feet about losing my wrist watch but finally my scientific impulse conquers and I put the watch on a brick and back off to shoot loose an electron off that luminous dial. I guess the sights must have been way off because I missed it time after time. Finally just as I hit it good and square, but before I could run over and collect

Fig. 2. I dig out grandpappy's old 30-32

some electrons, a cop rides up with his siren wailing and very, very much annoyed. I have an awful time with him but finally persuade him that I'm trying to locate a shell with an experimental time fuse that got lost during the war and is about to explode, this being a track away from the plant where that was done on a small scale. He is skeptical and does not understand the science of propogation of sound waves through earth and reflection by foreign bodies such as oil companies use in prospecting. He is even skeptical, but not as pugnacious, after I take him over to the lab and the boys there give him a good working over, showing how they work with me and the oscilloscope to pick up the echo. We do better over at my office. However, when he leaves I got no electrons, no watch and only an empty bottle which is quite serious in Ohio where they still ration drinking liquor and snakes and colds are very prevalent. Feeling very low I go home after telling the night man to bury some trash in the hole and fill it up wanting some good excuse to give the Boss when he jumped me in the morning for causing all the commotion.

That night I'm just getting into bed waiting for the wife to open the window and turn out the light when there is an explosion that rocks the house or at least rattles the windows. Before I get my pants on, the phone rings and says the plant blew up and have I a statement for the newspapers. I rush over through the back gate and have an awful time getting in because old John can't find his keys on account of how he is so upset because his gas stove has gone out and he can't make his coffee and because there was an earthquake all of which he tries to tell me while he is fumbling around and being stone deaf does not know there has been an explosion.

When I get through finally my friend the cop is having the time of his life telling about the last shell and the time fuse and war time experimental work on such a scale that the atom bomb was like a sling shot. By the time I find out what happened and where everyone has gone, I put two and two together and find out that paint rags, tin cans, paper and waste acid from the plating tanks were all put into the hole and

[1] Editor's Note: Very obviously a Geiger Counter.

[2] Another Editor's Note: A likely story. The Prof probably did not want to be bothered by a dope like Casey.

covered up with a young mountain because the shovel operator was a pal and couldn't bear to see men use a hand shovel in this mechanical age. The pit had been dug over an old gas line that I had been intending to remove and never did. Then I shot it all full of holes so the gas leaked up through the trash and the paint rags caught fire and I have a big headache.

Just then the boss buzzes up, all hot and bothered because he had been called away from a party and thought the whole plant was blown up. When he arrives all dressed up in tails every one but me and a few others had gone. What, says he, is this nonsense about an old shell exploding when you know we never had anything to do with anything bigger than a good sized firecracker. He wants to see the hole and yells at me all the way over so I never gets a chance to say a word but figure as soon as possible I better tell the story. The gas did a swell job and laid a small ledge of rock as clean as a whistle. What's the meaning of this he says finally and has to stop for breath.

"Well," I says, "when you mentioned the new press I figured you not only wanted the best but you wanted it quick so—"

"You numbskull," says he, "why couldn't you have waited till morning and had the shovel dig the foundation instead of dynamiting it out and scaring the whole town to death as well as making me miss the best part of a good party. That is a nice bit of rock," he says, taking the flashlight himself and taking a better look. "But how in blazes did you know I wanted it here?" he goes on in a nasty voice because he don't like people guessing what he has in mind, and then I began to get his drift and connect up with the times I'd seen him walking over this little hill recently.

"What I want is people to mind their own business around here, I'll do the thinking. Today I bought a press that is being trucked over. Foundation prints will be in by airmail tomorrow. You get the foundation bolts and a template made and pour the foundations, in the regular way without anymore nonsense. Then you move Sol over, lock stock and barrel and set him up in business fast before he makes a better job of blowing up the whole plant than you did tonight. This," he says, taking another good look into the dark, "is a beautiful site for a new plant, only good foundation on the place, gravity flow of materials but don't you dare try any of your hairbrained schemes on this till I get back. And don't say anything about the newspaper stories. Nobody is hurt and no more explosives so the publicity won't do any harm and may do some good unless you open your big mouth and spoil it all." So I figure he's so pleased with himself that he's not too sore with me.

So we go back and he says he is taking a midnight flight to Washington and telephones home for his bags and clothes. "Now," he says, "you made me miss a party so we will just try that bottle you keep tucked away." So I don't feel so good again with the bottle all empty. "Don't stand there like a statue," he says so I shuffle out and come back with a bottle of gin and a can of orange juice. "Orange Blossoms are very nice," I venture as on opening —"For them as likes them," says he, "but nothing at all for a direct descendant of Santa Claus," says he, "so stop the nonsense." So he goes and rummages all through my place and mumbles he will use his own and won't give me any. So he digs around in his cabinet and lays out a whole row of empties with just a drop in each. Finally he says, "Nicky, I guess it happens to everyone occasionally."

"I want," he says over the phone, "two cases within ten minutes and see that one gets into Nicky's office. That Irish tightwad won't buy his own and if visitors come they will think I don't pay him enough and he will probably organize them and have them picket the joint." So I went down to the cafeteria and got some ice while the Boss dressed and finally took him down to the plane so he would not get talking to some careless character and learn anymore about my scientific investigation.

Now, Mr. Editor when I got back from the hole and sat down in my office before the Boss came, I looked at your magazine and tore it up and threw it in the waste basket which I am going to be sorry for tomorrow on account it is not mine. I says to myself it would serve him right if I cancelled my subscription if I had a subscription instead of reading somebody elses paper. Let that be a lesson to you and if you will send me a copy to replace the one I tore up I will try to forget all the trouble you caused me. It's getting so I don't even like fishin with a pole no more.

Yours scientifically (ex)
NICHOLAS CASEY

Editor's Note: It is extremely embarrassing to have to admit that we have dopes like this guy Casey reading POWER PLANT ENGINEERING. We have little control over who reads the paper, however, and if such dopes happen to get hold of the bosses copy and as a result of their inability to comprehend what is in it blow up the plant we can't help it. Our only advice is to keep your copy of P.P.E. locked up where such morons can't get hold of it. Of all the crazy things—trying to make a hydraulic press with electrons when all he needs is a Buck Rogers Atomic Pistol, Model U-235. See page 8 of our January 1947 issue. As explained there, he can get this pistol for 98 cents, FOB Plymouth, Michigan from the Daisy Manufacturing Co., whereas a can of first-grade electrons at the present OPA ceiling would cost him 89 billion dollars! If this guy Casey had

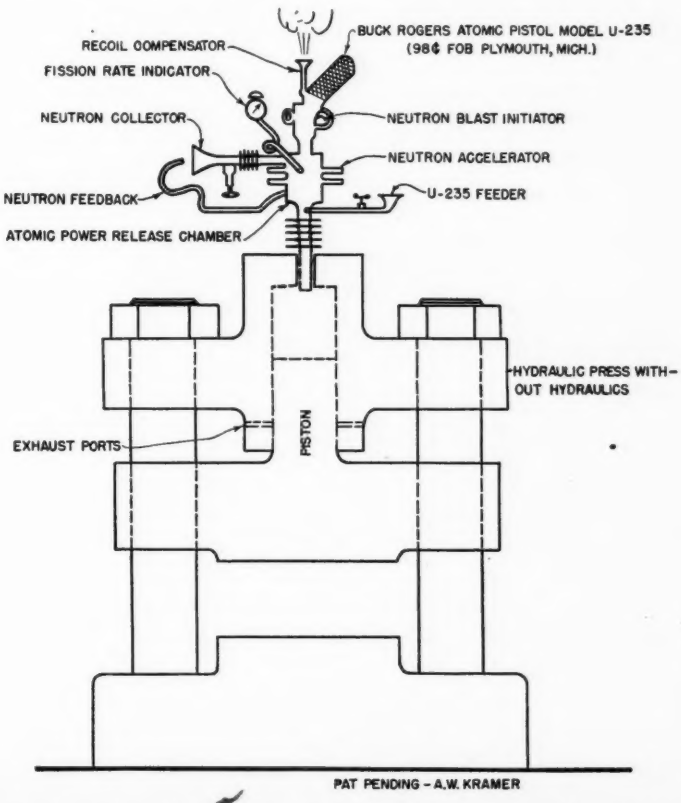


Fig. 3. Here is how it should be done. The 98 cent Buck Rogers Pistol is merely stuck in the top of the press. Question: How does the press get back "up"? Answer: That's your problem—we merely tell you how to get it down

any sense at all, he would see that all he has to do is to mount this pistol in the top of a press as shown in the accompanying sketch, squeeze the Neu-

Fig. 4. A picture of Casey, alias Petromorovitch, alias Richard H. Morris, and heaven knows what else

tron Blast Initiator, and Presto, he gets all the pressure he wants.

Since receiving this letter, we have been trying to find out something about this fellow, Casey. His letter came from the Air Materiel Command at Dayton, Ohio. The whole thing looked suspicious so we put the FBI on the case. Their investigations are not yet complete but preliminary reports seem to indicate that this guy Casey is in the Misguided Missiles Division of the Army Air Forces. Furthermore, he is obviously not Irish since records show that he wore whiskers until he got in the Army and he changed his name several times. At one time, it seems, he went by the name of Morris and he got into the Army by claiming to have been an editor on the staff of POWER PLANT ENGINEERING. This, of course, is an obvious falsehood. We never had anyone by the name of Morris on our editorial staff nor would we ever hire an editor with whiskers. So the whole thing is a frame-up. FBI investigators found a large number of empty Vodka bottles around Casey's premises and also some strange looking documents bearing the name of Petromorovitch. This, it appears is his real name. There was a little photograph hooked on to one of the documents which seemed to be a forged passport. This, as shown, carries the name, Richard H. Morris. Somehow, the face looks familiar but nobody around the office here can remember ever seeing this person.

LETTERS AND COMMENTS

A LETTER FROM INDIA

Pulgaon, (C.P.)
March, 1947

Dear Sir:

I acknowledge with many thanks your letter dated the 9th January, 1947. I am really grateful to you and your firm for guiding and helping me to attain my cherished desire. I have already received response from American engineer friends through your generosity (publishing my letter in P.P.E. February issue). Their surprising quick response overwhelmed me with joy and gratitude. I have also received through your kind favour, interesting and educative bulletins from individual manufacturing firms.

Your January issue with its well designed cover page and nicely written contents has come out a superb journal. Your article on Trends and Developments on Power Industry has revealed revolutionary possibilities in the power game. We look with admiration on your country's effort in future developments which will benefit not only you but the world at large.

I thank you for recommending a few good text books on power generation. Could you suggest me a good book on gas turbine as well? Gas turbines have immense possibilities in future developments on industrial power units.

Your answers to my questions have cleared the slightest doubt I had on the aspect of industrial power plants. Hope you will also help me to solve my problems.

Given below are the analysis of coal mined in C.P. area. I would like to know how best it can be burned in small and large boilers. Can it be efficiently burned by means of cyclone coal burners in 55,000 lb per hr, water tube B & W boilers?

Fixed carbon 43%
Volatile Hydro carbon 24%
Ash 23%
Moisture 10%
Caloric Valve
9700 approx.

Thermal efficiency in industrial and utility power stations are very poor in our country. So a little refinement in heat balance may improve things a lot.

Again let me thank you and all my generous American friends for helping me so kindly.

P. K. NAG

[1] See, Wanted, Job in Super Power Station, page 87 Feb. issue and also, article with same title, page 98 Feb. issue.

MAYBE YOU LASSO IT

I HAVE just read the article "Old Man Accident" by John Reynolds in the April issue.

How in H--l is a guy going to guy a pole unless he climbs it? I have done a lot of climbing and I never did trust a set of pikes if the pole was rotted at the bottom. The best way is to spud in a short pole and bolt both together.

Santa Barbara, Cal. O. R. WELSH

SOME FORCE, ELMER

IN MR. KRAMER'S article, Nuclear Energy and Electric Power in the March issue, on page 106, he shows how two grams if collected and placed one centimeter apart would repel each other with a force of 320×10^{24} tons.

It occurred to me to compare this force with the weight of the whole earth. Reaching in to my three foot shelf for Baker's Astronomy, I find the weight of the earth, given as 6.6×10^{21} tons.

If this value is reasonable correct

$$\frac{320 \times 10^{24}}{6.6 \times 10^{21}} = 48{,}484$$

Thus, the force between the two grams of electrons would be able to support 48,484 entire earths, if there was any base to set them on.

It would seem that two grams of electrons suddenly concentrated at the center of the earth would be able to shatter it into many fragments. If the electrons were placed at the poles of the earth, that is if they were separated by the polar diameter of the earth, the repulsion would still be about 26×10^8 tons!

$$\frac{230 \times 10^{24}}{12{,}714^2 \times 10^{10}} = 26 \times 10^8$$

where 12,714 km is the polar diameter and 10^{10} is the factor to convert to centimeters.

Pine Bluffs, Wyo.

ELMER H. HARVEY

SALT LAKE CITY'S SMOKE ORDINANCE

THE MARCH issue on page 75 contains a paragraph under the heading 'Boiler Settings' which makes a reader wonder why simple English was ever devised and never learned by so many writers.

Here is what it says: 'Boiler Settings —Boiler Settings shall be so constructed that mechanical firing equipment may be installed with a minimum furnace volume of not less than 36,000 Btu input per cubic foot per hour when the boiler is operated at maximum rating.'

The writer presumes the intention of this paragraph is to limit the Btu input to a maximum of 36,000 Btu per hour per cubic foot of furnace volume, when the boiler is operating at maximum output.

IRA A. BUTCHER

Reference to the printed ordinance proved that the paragraph to which Mr. Butcher refers was correctly quoted in the article, but Mr. Butler, the city engineer, states that he has long been aware that the specified paragraph is misleading. However, inasmuch as he and his staff know its meaning, it has been left intact; the difficulty of making the change would be very troublesome. The interpretation given is that not less than one cubic foot of furnace volume must be provided for each 36,000 Btu of heat release, or no more than 36,000 Btu may be fired at maximum rating per cubic foot of furnace volume.—Editor.

ENGINEER'S GOLD MINE

REFERRING TO SEVERAL articles appearing under the above subject, I have found that the collection of information and data of an engineering nature is not difficult but the real difficulty is trying to lay one's hands on a particular piece of information when it is wanted. Years ago I gave consideration to the making up of an index covering the whole range of subjects in which I was interested. I then arranged tabs in a loose leaf binder. Inti this book went copies of letters, specifications, prints, sketches, but most of all clippings from technical magazines. This book finally grew into a total of eight volumes. Of course it was necessary once in awhile to add a new subject to the index, but in the main the original arrangement of subject matters did not have to be changed very much.

R.F.E.

WHAT IS CORRECT PROCEDURE IF WATER LEVEL IS DOUBTFUL?

AT THE top of page 51 in POWER PLANT ENGINEERING Questions and Answers, Eighth Edition, is a statement regarding procedure when low water level is discovered that I should like to criticize.

The question under the subject of feedwater level, at the top of page 51, asks if it is safe to start feedwater into the boiler without checking the fire, if the water has dropped out of sight in the glass. The last sentence of the answer to this question says "If there is any doubt regarding the height of water in the boiler, it is best to check your fire before feeding." This is the statement I wish to comment on.

Having served as a boiler inspector, I know that sort of practice has caused many boiler failures, some disastrous. Where there is any doubt as to the exact water level in a boiler in service, the procedure should be as follows:

In firing with gas, oil or pulverized fuel, shut off the fire immediately. If firing with coal or coke, shut off the fuel feed and smother the fire with wet ashes, earth or even green coal. Do not attempt to pull the fire; that is when it is hottest. Maintain boiler outlet dampers normal. Close the bottom draft, admit a little draft over the fire and increase this overfire draft gradually.

Do not alter the feedwater supply; and if the boiler is supplying steam to an engine, turbine or other equipment, do not alter these. Contitnue everything as near normal as possible, except the fire and draft. Just let the boiler die a natural death. After the steam pressure has become too low to operate pumps and auxiliaries, let the boiler cool off until it can be safely drained and opened for inspection.

Notify your boiler inspector as far in advance as possible when it will be available for inspection, and have him help you inspect it before putting it back in service.

In brief, *never, never,* NEVER fire a boiler when you are not absolutely sure where the water level is.

I am surprised at finding a statement such as that quoted above in your handbook, for it is on the whole an excellent book—in fact, one of the best in circulation, I think, and I have read many of them. I am sure its contents are accepted as authority by many operators That is all the more reason why such answers should not be published; for many student firemen and apprentice engineers may follow these instructions.

Phoenix, Arizona GLENN BROWNING

Editor's Note—We certainly agree with Mr. Browning that the statement he questions is unclear, to say the least, and that, to be perfectly safe, instructions should be given right at that point on just what to do.

As a matter of fact, those instruction are given elsewhere in the same section of the Q & A Book, namely, on page 59, under discussion of what to do if you get high water level or low water level in the boiler. Consequently, anybody reading the entire section all at once will get the complete instructions, but if he stops right there at the sentence Mr. Browning criticizes, he certainly will not.

There is some evidence in our back files to show that, in previous editions of the Q & A Book, this point was explained in greater detail but that, for some reason, part of this explanation was dropped out in later editions. We cannot understand why this was done; furthermore we are not absolutely sure of it, for the records are very old and hard to check.

However, we call it to readers' attention here so that they can insert Mr. Browning's comments on page 51 if they agree with them, and also compare them with the details given on page 59 of the Eighth Edition. Necessary corrections and correlation of all this information will be made in the Ninth Edition of the Q & A Book.

Questions And Answers

Question No. 386

WHAT MAKES THE BOILER DRUM BUMP?

I WOULD LIKE to know what causes or might cause a boiler drum to bump in warming up and cooling down. When it occurs, it sounds as if a manhole crowfoot might be centering itself and the drum receives a considerable jar. The boiler is a 120-hp, 3-drum Stirling and the bump appears to be in the steam drum.

It has been noticed three times. The first time the boiler was being steamed up and when it had 25 lb steam pressure, there were two bumps, 2 or 3 minutes apart. The second time, the boiler was being washed, with the manhole covers and steam baffles removed. There was one bump. The third time the boiler had been under load, on the line for 5 or 6 hours, and there were two bumps 3 hr apart. These have not occurred at any other time.

The first time it was decided that a crowfoot did center itself, although we center them with a hammer as they are tightened. But the second time, there were no baffles nor crowfoots on the boiler, so they are both eliminated. After that it was reasoned that the supporting lugs on the drum had worn a depression on their seats which might cause considerable pressure to be applied before the drum could be moved out of them. These were lubricated but the third bumps happened just the same.

About 11 years ago, the boiler had two tubes from No. 1 bank and all

tubes from Nos. 11, 12, 13 and 14 replaced; no more have been replaced since that time.

The boiler inspector is unable to determine the cause of the noise. So we would like to have any information or ideas from Q & A readers.

Great Bend, Kans. C.L.S.

Question No. 387

HOW CALCULATE SIZE OF FILLING AND EQUALIZING PIPES?

IN ONE of our plants, we treat wood in a wood preservation plant and in part of the process use the arrangement shown in the attached sketch. This consists of two pressure vessels and the interconnecting piping, as shown, for Rueping treatments.

The initial steps in the Rueping process consist of:

1. Charging the treating cylinder with wood loaded on standard-gage tram cars;
2. Filling the upper (Rueping) tank with creosote oil;
3. Filling the treating cylinder voids and the cells of the wood with compressed air. The final air pressure varies, but for this problem say it is 75 psi;
4. Dropping oil from the Rueping tank into the treating cylinders, maintaining 75 psi pressure in the treating cylinder until it is filled.

The size of the line through which oil is dropped and the size of the equalizing line must be determined to permit filling the treating cylinder with creosote in 10 minutes. An exact calculation of these pipe sizes would, of course, involve consideration of viscosity of the oil, orifice coefficients, pipeline losses, etc. However, I am not so much interested in an exact answer as in seeing the step-by-step method for finding these pipe sizes.

In short, for determination of the oil line size, what I need to know is how to make the calculations for determining what time is required to empty the Rueping tank filled with water (for easier figuring) to atmosphere through an 8-in. diameter orifice in its bottom. If I have that, it will be the basic information for determining the oil line size.

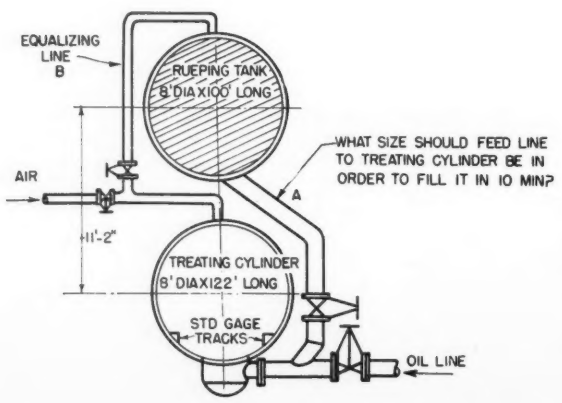

EQUALIZING LINE B
RUEPING TANK 8'DIAX100' LONG
WHAT SIZE SHOULD FEED LINE TO TREATING CYLINDER BE IN ORDER TO FILL IT IN 10 MIN?
AIR
A
11'-2"
TREATING CYLINDER 8'DIAX122' LONG
STD GAGE TRACKS
OIL LINE

Diagram showing connections of pressure vessels and piping for Rueping process of wood preservation, for calculation of size of pipe "A" and equalizing line "B"

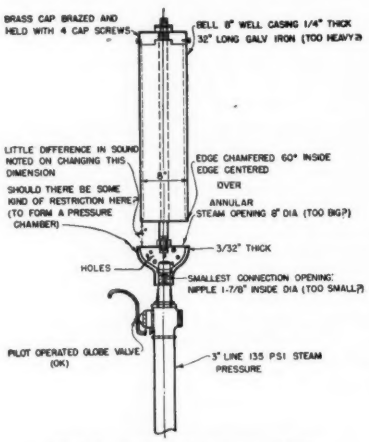
But how can the equalizing line size be calculated under the above operating conditions?

Chicago, Ill. B.E.

Question No. 388

HOW CAN HE MAKE THIS WHISTLE LOUDER?

PLEASE GIVE me all available information on the design of a large steam shop whistle. I have one, as shown in the sketch, which was taken apart and rebuilt by my predecessor in this plant. Now, in spite of much adjustment and changing, it still fails to produce sufficient volume of sound. Please give me what you can on these questions.


BRASS CAP BRAZED AND HELD WITH 4 CAP SCREWS
BELL 8" WELL CASING 1/4" THICK 32" LONG GALV IRON (TOO HEAVY?)
LITTLE DIFFERENCE IN SOUND NOTED ON CHANGING THIS DIMENSION
EDGE CHAMFERED 60° INSIDE EDGE CENTERED OVER ANNULAR STEAM OPENING 8" DIA (TOO BIG?)
SHOULD THERE BE SOME KIND OF RESTRICTION HERE? (TO FORM A PRESSURE CHAMBER)
3/32" THICK
HOLES
SMALLEST CONNECTION OPENING: NIPPLE 1-7/8" INSIDE DIA (TOO SMALL?)
PILOT OPERATED GLOBE VALVE (OK)
3" LINE 135 PSI STEAM PRESSURE

Sketch of J.W.D.'s steam whistle

Should the annular opening just under the bell be equal in area to or less than the area of the smallest connection in the steam supply line? What is the desirable ratio of bell diameter to length of bell? What actually produces the sound? Is it due to vibration of the bell itself on the surrounding air?

Chicago, Ill. J.W.D.

Question No. 389

WHAT'S THE BEST AIRCRAFT NIGHT WARNING FOR A STACK?

CAN YOU HELP me out with a stack illumination problem? Our plant is quite close to an airport and, to warn airplane pilots off the stack at night, we have to use four 1500-watt flood lamps focused on the stack.

Now I would like to find some kind of rig—perhaps a pair of red lamps at the top of the stack—that would be more economical and at the same time include a convenient method for replacement of light bulbs.

What have other engineers done in situations of this kind?

Chicago, Ill. L.B.E.

Question No. 390

SHOULD HE REHEAT EXHAUST STEAM FOR PROCESS WORK?

WILL Q & A readers give me their opinions on a scheme I have for reheating exhaust steam to use in process work? The reason for considering the scheme is to try to get the greatest economy out of our power plant. Our factory is going to be moved to another building soon and proposals are being made to purchase all needed electricity from the power company for 1¾ cents per kilowatt-hour, and generate only low pressure steam for our processes.

In our present plant we operate an 80-hp HRT boiler at 125 psi gage, and a small steam engine driving a d-c generator supplying only part of our current (motors and part of the lights). This engine exhausts at 5 psi gage. At present we use approximately the full boiler horsepower for processing on one shift, at pressures of 50 and 25 psi through reducing valves. The process steam is used in certain kettles and mixers.

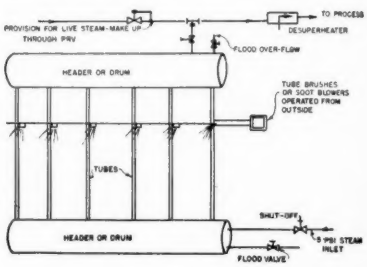


Diagram of M.M.G.'s reheater for 5-psi exhaust steam to be installed in uptake of boiler to supply hotter process steam

When we move to our new plant, we will have a floor space of 250,000 sq ft to be lighted and heated. In the new plant there are now two low pressure boilers, one a 166-hp unit, one a 95-hp unit, but the latter is to be removed. The company plans to order a new 100-hp water-tube boiler to supply high-pressure steam in the new plant. Also in the new plant we will be burning oil instead of coal as at present. Perhaps in the summer we shall be able to burn gas in the high pressure boiler only.

By counters on condensate traps, I estimate I now generate from 50,000 to 65,000 lb per day of 21 hours, including 5 hours of preheating time in the process kettles, 5 days per week. In addition, we run from 8 to 10 hours on Sunday night.

One part of my idea for the new

plant was to figure on purchasing a new engine and an alternating current generator to take care of all power needs.

Another idea was that if the engine exhausts at 5 psi gage, I might take the exhaust steam and run it through some sort of a reheating device as shown in the sketch, installed in the smoke box or flue of the boiler. The object would be to raise the temperature of the 5 psi steam to approximately that of the 50-lb and 25-lb live steam we are now using. I could then supply this superheated 5-lb steam to the processes and avoid having to draw live steam through the reducing valves.

Michigan M.M.G.

Answer No. 365

WHAT SHOULD BE DONE ABOUT THIS OLD PLANT?

HIS PLANT is very old, C.H.T. said in the February issue, giving details of steam output normally averaging 140,000 lb steam per hr from 7 water-tube boilers, fired with 13,500-Btu coal, some burned in stokers, some fired in pulverized form. Coal consumption is about 2800 tons a month. His feedwater temperature has recently been brought up to 200 F. He has 95 per cent make-up, but when a new process plant is finished he will have about 20,000 lb per hr of condensate returned to the power plant.

His management feels that any power plant is a necessary evil, especially this old one. How can he convince them that their present plant can be converted into an asset, instead of being considered a liability?

C.H.T. Must Do a Selling Job, Says Brown

THIS QUESTION comes up in many industrial plants, especially where the output of the plant is not properly metered. I worked in one generating plant where there was not even a watt-hour meter. Later, when electric current was purchased, lights that had been burning 24 hours a day for years were turned off when not needed, to save on electric bills. But as long as the plant was supplying its own current, no one bothered to turn off a light when it was not needed.

Where the products of the power plant are not properly metered, the power plant must absorb the waste of power and steam by other departments. In one large plant, the company decided to install a meter on the steam used for heating. The amount of steam used in addition to the exhaust from the generating plant, had been guessed at for years. After they installed a much larger meter than was necessary, the hand on the meter went all the way over and hit the pin, so that it was necessary to install a still larger meter. The power plant had been getting a black eye for current and steam. This incident happened several years ago. The generating plant is still operating.

Every operating engineer should take a course in power plant accounting; then his monthly reports would do much to prove that the power plant was not just a necessary evil but in most cases a profitable investment.

The management, as a rule, are much more interested in how much steam and power is *costing* than they are in how much is produced.

The only value in knowing the amount of steam produced or used per hour is that from such figures you can judge the size of the plant needed or what the demand charge will be if steam is purchased.

C.H.T. does not say what his boiler and furnace efficiency are or the number of hours that his plant operates. He gives us the pounds of steam per hour and the tons of coal per month; from those figures you can get all kinds of efficiencies.

From the description of the boilers, some of them should have an overall efficiency of about 80 per cent. Had he given the gas temperature at the boiler exit and per cent of CO_2 in the flue gases, then it would have been possible to make some definite suggestions.

I would suggest that he send for a booklet entitled "Dividends from Your Power Plant." There is no charge for the book and it does not contain any advertising. It contains a great deal of information that is of value to both managers and engineers.

There is no doubt that what it would pay to install some new boilers, but perhaps some of the old ones could be made to put out more pounds of steam per pound of coal.

If the condensate could be returned to the boilers, considerable savings could be made not only in heat returned in the water but also in the amount of feedwater treatment and the amount of heat lost in blowing down.

C.H.T. has a selling job to do. He not only has a selling job to do but must also prove that he is producing steam and power cheaper than it can be bought. In figuring purchased steam and power he should not forget that little item called the demand charge, because it really does boost the bill.

Lombard, Ill. H. D. BROWN

Editor's Note:—The booklet, Dividends from Your Power Plant, referred to by Mr. Brown, is actually written to help the engineer show the manager how he can use what the engineer knows. If every engineer knew how to get his management to look at it as this booklet shows, Question No. 365 would seldom come up. If you want a copy of the booklet, we'll tell you where and how to get it.

Answer No. 371

HOW CALCULATE JOINT EFFICIENCY?

WHAT IS THE correct way of figuring the efficiency of a double-riveted butt-strap joint in which t = ½ in.; TS = 60,000 psi; rivets are ⅞ in. dia; rivet pitch is 2¾ in. E.W.G. asked this question in the March issue, stating it was given in an examination and had aroused considerable controversy among his boiler operators.

Because so little information was given in the original problem, several engineers are sure that what the examiner wanted was the short formula $[(P - d) \div P] \times 100$ = joint efficiency in per cent. This could readily be obtained from the data given, for reasons given below by Goldsmith, Bailey and others.

First, however, since many men are scared at the sight of a formula, here is a method of explaining it in words.

Rules Written Out By Harding

SOME BOILER ROOM operators are discouraged by formidable-looking algebraic formulas. They can better understand the written rule.

To find the strength of a riveted joint, the tensile strength of a unit strip of a solid boiler plate must be found first.

To find the strength of a unit strip:

Multiply together the length of the unit strip (pitch) in inches, the thickness of the plate, in inches, and the tensile strength of the plate material in psi.

Applied to the problem in question:

2.75 in. × 0.5 in. × 60,000 lb = 82,500 lb

The next step is to find the weakest part of the joint and divide it by the answer just obtained.

In finding the weakest part, three forces have to be contended with. They are (1) shearing of the rivets; (2) rupturing of the plate between the rivets, and (3) the crushing of the rivets or the plate in front of the rivets.

Rule to find shearing strength of rivets:

Multiply together the area in square inches, of one rivet, the number of rivets in unit strip, and the shearing strength in psi, of the rivet material

Applied to the problem:

0.601 × 2 × 40,000 (assumed) = 48,080 Rivets in double shear × 2 = 96,160 lb.

To find the strength of the joint between the rivets:

Subtract the diameter of the rivet hole from the width of the unit strip, in inches. Then multiply together the value just obtained, the thickness of plate and the tensile strength of the material in psi.

Applied to the problem:

(2.75 in − 0.875 in.) × 0.5 in × 60,000 lb = 56,250 lb

To find crushing strength:

Multiply together the number of rivets, the diameter of one rivet, the thickness of plate, and the crushing strength of the material.

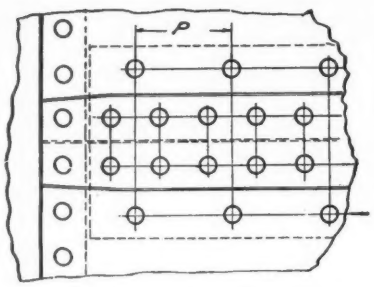
Applied to the problem:

2 × 0.875 in. × 0.5 in. × 90,000 lb (assumed) = 78,750 lb

The joint seems to be weakest between the rivets. Dividing this by the strength of a unit strip of solid plate gives an efficiency of approximately 68 per cent, thus

56,250 ÷ 82,500 = 0.6818 = 68.2 per cent

The above rules should be good enough to solve an examination question of this kind. Of course, there are more detailed methods in the Boiler Code and



Example of butt and double-strap joint, double riveted

in various technical books such as Croft's "Steam Boilers."

Morristown, N.J. WILLIAM J. HARDING

Many readers have sent in solutions and most of them have pointed out that the information given is not complete and some assumptions had to be made. For one thing, it was not clear whether the rivet pitch given was for the inside or the outside row of rivets and that makes a difference.

The correct and complete method of calculation is that given by the ASME Rules for the Construction of Power Boilers. In the 1943 edition, the method is shown on page 154. In the 1946 edition, which has just been published, it appears on page 184. In the latter, it is specifically stated that the value for P is that for the row of rivets having greatest pitch. If you assume, as some answerers did, that the 2¾ in. pitch given was for the inner row and the outer row was 2 × 2.75 or 5.50 in. then you get different answers.

The given TS of 60,000 psi also differs from the TS of 55,000 used in the examples in the 1946 Code.

Finally, some answerers discussed the characteristics of the joint and concluded it was not a very good one. Several used the Massachusetts and Ohio boiler code methods, which are, of course, very close to the ASME Code.

First, however, consider this point about the rivet pitch raised by H. J. Hobaugh of Vallejo, Calif., who said:

"IN THIS QUESTION, where rivet pitch is given as 2.75 in., I assume is meant the pitch of rivets on the row having greatest pitch. This, upon inspection, would indicate that the joint is incorrectly designed.

"There are two rivets in a unit length of joint in the inner row of a butt- and double-strap joint, double riveted. Par. P-255 of the ASME Code, Power Boilers, states that rivets shall be of sufficient length to completely fill the holes and form heads at least equal in strength to the bodies of the rivets. The least diameter of a rivet head is that of the High Button Head, as shown in Fig. A-13 of acceptable forms of rivet heads after driving, which is 1.63 of the rivet diameter. In this case, 1.63 × 0.875 × 2 = 2.8525 in., which is greater than the pitch. In other words, there isn't space for the rivet heads."

Mr. Hobaugh then calculated the joint efficiency by the ASME code method. He found that H, the strength of buttstraps between rivet holes in inner row, had the least strength; but he pointed out that the code says H need be calculated only for old boilers with thin buttstraps. However, since it has the least strength, he used it. Dividing H, which he calculated to be 52,500 by A, the strength of solid plate, which he calculated to be 82,500, he obtained joint efficiency of 64 per cent.

For lack of space, his complete numerical calculation cannot be given here but will be shown in the next issue.

But, if Mr. Hobaugh had assumed a new boiler, neglected H, and used the next lowest value, B, the strength of plate between rivet holes, his efficiency would have come out B ÷ A = 56,250 ÷ 82,500 = 0.68 = 68 per cent.

Using the same method of calculation and also calling attention to the discrepancy in rivet pitch but assuming it to be 2¾ in. as the outside pitch, in order to show the method of calculation, several other readers also calculated the efficiency to be 68 per cent. Among them are: Albert H. Moulton, Pittsfield, Mass.; Alfred F. Bailey, Stratford, Conn.; Ralph B. Goldsmith, Jr., Beverley, Mass.; C. A. Wilkes, Oaklyn, N.J.; William T. Mullen, Philadelphia, Pa.; M. Doumas, New York. Besides figuring the joint, they made some pertinent comments on the design of the joint. These and other reader comments will be given in a future issue.

Answer No. 374

WHAT ARE DUTIES OF WATCH ENGINEER, FIREMAN, OILER?

THIS QUESTION in the April issue brought out some fine information from readers particularly on the relations between the various duties as well as the responsibilities of each man. Here are a few of the comments.

Duties Outlined By Cuttita

APPROXIMATELY a year following our entry into World War II, quite a controversy arose involving our Water Tenders, Firemen and Maintenance Men here at our plant, as to what duties applied to their respective classifications.

Although their various classifications definitely define certain duties, incidents arise occasionally where mishaps, negligence, or incompetence prevail. These enable men to "pass the buck" from one person to another. To avoid an excess amount of this buck-passing, each individual should assume certain responsibilities, for his own protection as well as those relieving him on the respective shift.

Following will be the major factors each classification covers. They are not complete in every detail, but merely a summation of what we expect of our department personnel. Incidentally, our boilers are oil fired.

Fireman

1. Start and shut down boilers
2. Start and stop forced draft fans
3. Maintain boiler pressure
4. Clean and change oil burners
5. Keep stack clear of smoke
6. Pop test safety valves (periodically)
7. Assist Water Tender in emergency

Water Tender

1. Maintain water level in boilers and hot water heater
2. Check and lubricate water and oil feed pumps
3. Check temperature of oil and hot water heaters
4. Start and stop induced draft fan
5. Open and close main head valves
6. Blow boilers down
7. Assist Fireman in emergency

Utility Man

One each operating shift, to assist Fireman or Water Tender in any detail of work; also available at any time to take over the duties of Fireman or Water Tender in case of sickness, accident or absence.

Boiler Maker

1. Repair and condition boilers
2. Repair and condition oil and hot water heaters
3. Repair and condition (also flush) economizer
4. Prepare boilers for annual inspection

All with the able assistance of his boiler-cleaning crew; also to aid machinist in emergency.

Machinist

1. Repair and condition oil and feedwater pumps
2. Repair and condition induced and forced draft fans
3. Adjust and condition water and steam flow meters
4. Adjust and test gages and safety valves
5. Adjust and set booster, reducer and relief valves

Also aid boiler maker and crew in emergency.

Passaic, N.J. A. F. CUTTITTA

Job Details From Pef

IN POWER PLANTS where three men are employed, the most logical designation of the titles is: fireman for the man who fires the boiler; oiler for the man who oils the equipment in the engine room; and engineer for the man who is responsible for the operation of the entire plant. In some plants the engineer may be called watch engineer or shift engineer, and the oiler may be called helper; but whatever the name, in order of importance, the engineer is first, the fireman second and the oiler third.

Although in some plants, local conditions make it desirable to deviate from the orthodox order of duties, I shall give in what follows my conception of what are the usually accepted duties of the engineer, of the fireman and of the oiler, based on what is practiced in well managed plants:

1. **The oiler.** His job is to oil all equipment in the engine room, and unless a janitor is employed, the oiler's duty is also to keep the engine room clean. These are his cardinal duties.

He is also expected to start and stop all auxiliary equipment in the engine room and either start alone, or assist the engineer to start, the main equipment. The shutting down of the main equipment is done by the oiler. In case of emergency repairs, he is expected to help the engineer. The oiler may be called assistant engineer and has a better chance to grow to an engineer than the fireman; for the fireman does not have the opportunity the oiler has to be with the engineer as often. Whether an oiler becomes an engineer depends on how willing he is to help the engineer and to take off his hands as much work as possible.

2. **The fireman.** The fireman's duty is to tend the boiler. To watch the water and keep up the steam are his cardinal duties, and he can not fail in these two if he wants to keep his job. Then he is supposed to blow down the boiler as directed by the engineer and blow the soot. If he has no helper, he must pass coal, pull the ashes and keep the boiler room clean. Oiling of the boiler room equipment is usually done by the fireman.

3. **The engineer.** The duty of the engineer is to co-ordinate the work of the fireman and the oiler, and to assist them in the better operation of the plant. Placing of the boiler on the line, testing of safety valves, testing of boiler water and maintaining boiler water concentration, placing of main units on the line are duties of the engineer, assisted by the fireman or oiler. A good engineer will pass as many of his duties to the oiler and fireman as they are willing to accept voluntarily, and as many as he feels they are capable of doing. In this way, he will be free to devote more time to the betterment of the plant. If the oiler is willing and capable of placing the main unit on the line the engineer would let him take indicator cards. If the fireman is willing to test the boiler water and make CO_2 tests, the engineer will let him do it. The engineer's duties are to keep the plant operating and to operate his shift efficiently. To operate the plant efficiently, he must devote some thought and attention to the work of the oiler and see if some oil can be cut down without impairing lubrication. He will spend some time with the fireman and assist him, if possible, to improve boiler efficiency.

The above outline of duties will not fit into the picture of every plant, but for plants whose size and equipment require three men, it should come close to defining the duties of each operator.

Dorchester, Mass. N. T. PEF

Comments from Sheffer

HERE IS a brief outline of the duties of various power plant employees, as outlined by this writer for a large engineering association. They apply especially to many types of industrial and institutional plants.

Incidentally, it is to be noted that in very few instances can an exact division of labor be attained, for some overlapping of duties must be expected. This especially applies to "hot" equipment, where the work of engineer and steamfitter is very similar.

Watch Engineer Or First Assistant Engineer

During an assigned watch, the engineer is in responsible charge of a high-pressure, high-voltage steam-electric generating plant. Several thousand horsepower of boiler capacity, and several thousand kilowatts of electrical capacity are installed in such a plant. Also a large variety of auxiliary apparatus such as: electrical, hydraulic, or pneumatic combustion control systems; reciprocating and centrifugal boiler feed pumps; hot and cold water pumps for domestic service; steam and electric-driven air compressors; engine-driven fans for combustion air.

He has charge of a crew of boiler operators, oilers, coal passers. He makes minor repairs and adjustments to the machinery in his charge, and keeps an accurate set of log sheets and records.

He has charge of the feedwater treatment, and makes the various chemical analyses that determine the conditioning of feed water.

Upon him rests the responsibilities for obtaining utmost efficiency of operation of the plant during his watch.

When detailed to the repair crew, he overhauls and repairs the main engines, fan engines, and stoker engines. Repairs and rebuilds mechanical stokers of various types, cleans and retubes boilers, rebuilds high-pressure steam valves. Repairs and retubes heat exchangers and ammonia condensers, and rebuilds ammonia and other refrigerating compressors. Overhauls and rebuilds reciprocating and centrifugal pumps, steam turbines and air compressors, coal handling machinery, ash dumping apparatus and combustion control meters.

He also repairs laundry machinery, such as extractors, washers and mangles.

Fireman

The fireman, or boiler operator, is in charge of the operation of a battery of high-pressure boilers, often of several thousand horsepower capacity. He works under the direct supervision of the watch engineer. He must have intelligence and ability so that he can co-operate with the engineer. He operates the mechanical stokers, tends water level, oils and cleans the boiler room equipment.

He is entrusted with the keeping of boiler room records.

When detailed to the repair crew, he assists the engineer with all the work undertaken, which is detailed under the duties of engineer.

In some boiler rooms, there are often installed pumps, heaters, heat exchangers. The fireman takes charge of these items.

Oiler

The oiler works under the direct supervision of the watch engineer. He cleans and oils the plant equipment, keeps close watch on all the machinery and in general makes himself useful in the plant.

He should be an individual with an exceptionally keen sense of perception, given to detail, and of a personality that will enable him to work in harmony, continually, with the engineer and fireman on his watch.

Steam Fitter

The steam fitter installs new high and low-pressure steam lines and equipment throughout the plant, and in staff cottages located on the grounds.

He runs new steam lines to new engines, turbines, pumps, heat exchangers, boilers and other apparatus.

He replaces obsolete and worn-out equipment with new, such as valves, reducing valves, steam traps, and, on occasion, completely dismantles old heating systems, made useless from various operating conditions, and replaces them with new systems.

He regulates the distribution of heat throughout the buildings, by operating the necessary valves and equipment. In this, considerable judgment is necessary, so as not to harm the lines. Also, an intimate knowledge of the steam lines throughout the plant is imperative.

Helper

The fitters helper assists the fitter in the above work, and does ordinary maintenance work alone, such as cutting gaskets, fitting gaskets, packing valve stems, replacing valve washers, cleaning and painting corroded spots on equipment, and related work.

Plumber

The plumber installs all the new plumbing throughout the plant. When obsolescence, damage, or ordinary wear makes necessary the replacing of plumbing equipment, the plumber installs new showers, baths, lavatories, sinks, etc.

He also installs, as required by changing conditions, new high-pressure water mains, pressure-reducing valves, and auxiliary equipment.

He installs and maintains a large number of complicated temperature control valves, and pressure control valves.

He replaces worn-out kitchen equipment, and repairs them if possible.

Helper

The helper assists the plumber in the above work, and, alone, cuts and fits gaskets, replaces valve washers, packs valve stems, glands, prepares pipe and fittings for use by the plumber, salvages joint metal, packing, gasket material, and otherwise makes himself useful. He cleans and rods out waste lines on toilets, sinks, basins, dish washers, floor drains, shower drains.

Wingdale, N.Y. W. SHEFFER

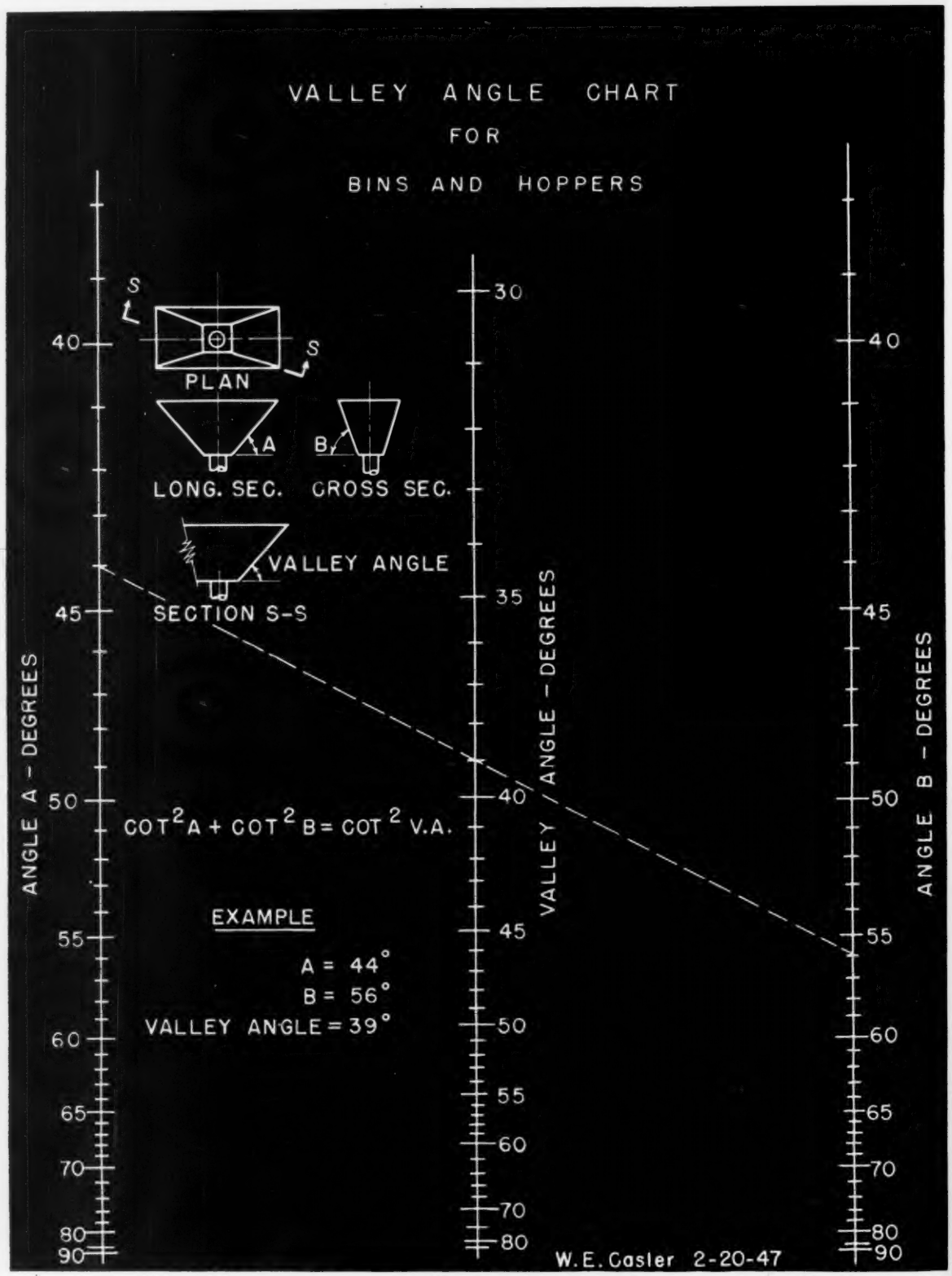


CHART FOR DESIGNING BINS OR HOPPERS

WHEN DESIGNING a bin or hopper with a wedge-shaped bottom the angle between the inclined sides and the horizontal is selected for a minimum value depending upon the material to be stored in the bin. However, the valley angle, or corner angle, which is the angle between the intersection of the inclined sides and the horizontal is always less than that of the inclined sides. This causes the material to stick in the corner while it slides freely down the sides. The angle should therefore represent a minimum value and the sides should be determined accordingly. This chart provides an easy method of finding the relationship of the valley angle to the inclined side angles. Place a straightedge across the two scales representing the adjacent side angles and the point where it intersects the middle scale gives the valley angle. (Walter E. Casler)

Developments in Pulverizer Design

THE COMPREHENSIVE research program now being pushed by the coal industry is supported in many ways by the efforts of fuel users and by the makers of combustion equipment. Engineers throughout the industry continue to extract new efficiency from coal and to develop equipment that helps to reduce smoke and fly ash.

An example of this effort on the equipment front is a new pulverizer developed by Blaw-Knox Co. that enables power and steam plants to feed coal to their boiler burners in a fluid stream. Known as the steam jet fuel pulverizer, it is produced in two models, a loop model and a circular type unit.

The unusual thing about this device is that it has no moving parts, except for a screw drive that feeds fuel into the unit. Superheated steam does the pulverizing. The powdered coal is then entrained by steam and delivered to the burners in a fluid stream, much like a gas. This stream-like movement of the fuel provides a high safety factor and permits precise control. Engineers report that the fluid-like coal achieves very complete combustion. As a result formation of smoke is reduced to a negligible quantity and fly ash is confined to mineral and unburnable residue. A production installation has been in service in a plant at Chillicothe, Ohio, for the past three years.

The pulverizer operates on either wet or dry coal; that is, the coal need not be pre-dried. The absence of moving parts, except for the screw feed, reduces maintenance. The units are small in size due to their vibrationless operation, can be set on ordinary floors without special foundations, nor is bolting to the floor necessary. They are adapted for capacities up to 10,000 lb of fuel per hour as required.

This mill is unique in the sense that for the steam consumption per hour it will pulverize almost equal quantities in pounds per hour of anthracite, bituminous coal, and coke breeze. These three fuels ordinarily are widely separated in Hardgrove grindability index factor. The performance of the circular mill in almost eliminating the effect of grindability factors on capacities is considered valuable and makes it a general utility pulverizer whose performance can be predicted despite required changes in fuel.

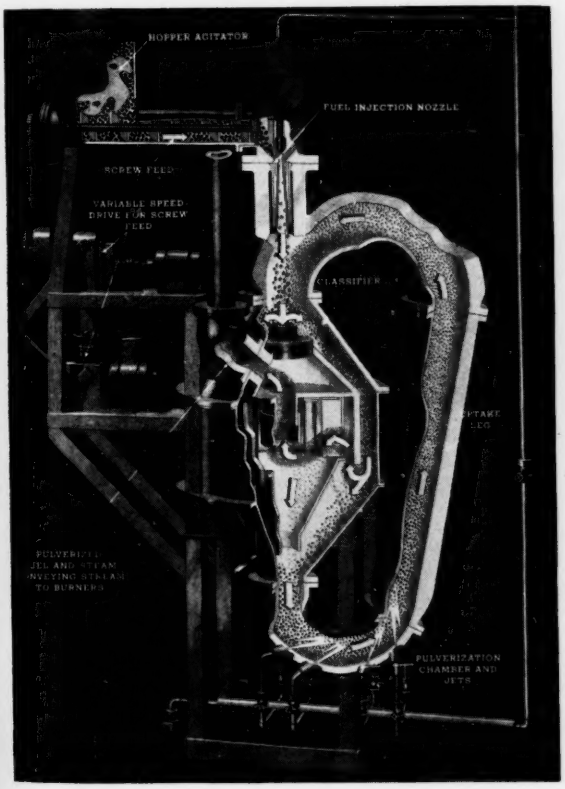
Pulverization is accomplished by high velocity impact expansion of the fuel, which is acted upon through nozzles and high temperature. In general, the mill uses from 0.05 to 0.06 lb of steam per pound of fuel pulverized when steam recovery system is used; pulverization is 90 per cent or better through a 200 mesh screen.

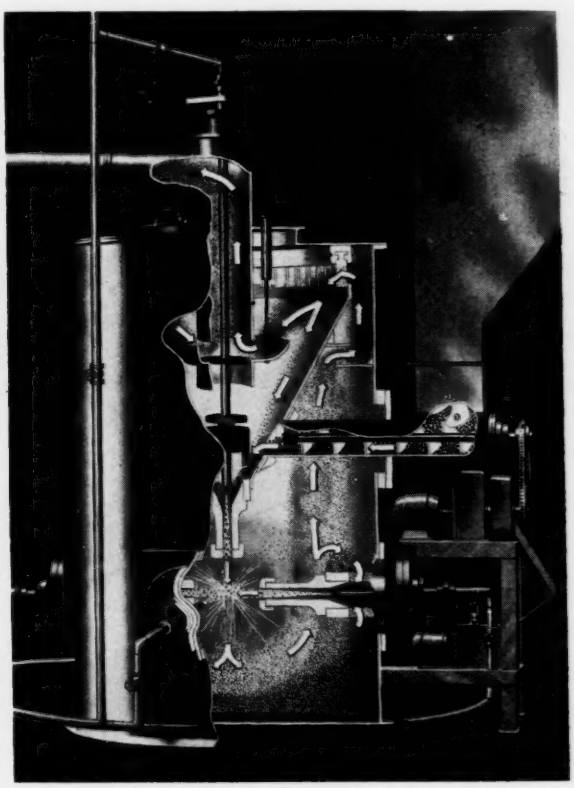
In operation, fuel of ⅜ in. size or under enters the pulverizer from an overhead bunker, into a box-like receptacle on top of the screw feed; an agitator is on the inside of this box to keep the fuel in motion and prevent clogging in the event there is an excessive amount of moisture in the fuel being used.

From the agitator box, the fuel is fed into the pulverizer by means of the screw feed. At this point where the fuel enters the pulverizer, there is a low pressure area created by the steam stream from the vertical steam jet located, as shown, in the center of the pulverizer.

Four steam jet nozzles are located on the inside of the pulverizer facing toward the center of the mill and are at 90 deg from each other. From these jets superheated steam at a total temperature of from 700 to 800 F at 100 psig is converging at a central point. Fuel is entrained by the superheated steam jets and when it enters the convergence area of the jets, it is disintegrated by the various and many forces set in action by the high velocity jets.

Fig. 1—Left. The loop model of the steam jet pulverizer has been installed in a plant at Chillicothe, Ohio, for the past three years. Fig. 2. The circular model is adapted for use in pulverizing a variety of solid fuels





What Voice Recording Can Do in the Power Industry

By **GEORGE W. DYSON**, Instructor, Machine and Metal Trades High School, New York City

ONE DOES NOT have to be an apologist for war—the greatest of all human tragedies—to make the bold statement that in many fields great gains are made as a result of war's destruction of old ideas and outmoded methods of thinking. This is particularly true in the field of engineering, where the blank checks drawn upon the United States Treasury made possible research and experimentation that would be impossible in the days of peace.

While attention has been drawn to the peace-time possibilities of atomic power, radar, gas turbines and other spectacular developments, many a device has slipped quietly into the power plant and is doing a first-rate job. For example, one of the minor developments of World War II has been practical voice recording equipment for industrial use.

Voice recording, of course, was practiced before Hitler marched into Poland. The embalming of the golden tones of Señor Adenoidal upon a disk constituted a major industry. Business relegated the secretary of the curvaceous calves to a back room while the busy executive dictated his deathless prose to a recording gadget. But voice recorders were not in wide-spread industrial use.

The armed forces soon realized that they needed reliable voice recorders. Communication circuits had to be monitored. Programs designed to train men in oral communication demanded recorders. Public relations men, anxious to secure "on-the-spot" descriptions of battle action, demanded recorders. Historical officers dragged their recorders into action and made play-by-play descriptions of the fighting. Recorders enlisted for the duration.

But the recording equipment that reported early in the war was entirely different from that which received its honorable discharge. The recruit was flimsy in construction, uncertain in operation and difficult of manipulation. There was a plethora of knobs, dials and switches. Salesmen—pardon me, sales engineers—talked learnedly of decibels, signal-to-noise ratios, fidelity and frequency of response.

The armed services took their collective feet down off their desks and glared at the disciples of the Great God High Pressure. In one voice they roared, "We want a recorder that will give us good intelligibility; that can be operated by an enlisted man with five thumbs on each hand; that will stand up under the severest operating conditions!" The manufacturers of recording equipment dropped a little oil on their slide rules. The result: a line of voice-recording equipment now available for industry that can be operated by untrained personnel and that will stand up under the kicking around that only military equipment receives.

Industrial Uses Limited Only By Imagination

But, where can such recorders be used in industry? The answer to that question is simply:—their use is limited only by the imagination of the people using the equipment. The problems of a major industrial plant are not unlike those of the army and navy. There are communication circuits to be monitored, conferences to be recorded, personnel to be trained and historical records to be kept.

Let us look for a moment at a public utility. The power dispatcher is constantly adjusting the loads on the various units to drain the last vestige of a Btu from a pound of coal. Action taken upon the basis of telephonic communication maintains the continuity of service of which the public utilities are justly proud.

In order that accurate records may be kept of the traffic on the telephones of the power dispatcher, they should be monitored. The resulting recording does not stem from the memory of any individual but is factual record, 100 per

Fig. 1. General view of four film-type voice recorders installed in two small cabinets in control room of public utility power plant

THE AUTHOR

When Mr. Dyson submitted this article to us a short time ago, he was still serving in the Navy, with the rank of Lieutenant-Commander, USNR.

Prior to that, he had spent most of his working life in the public utility field, with Consolidated Edison Co. of New York. Now, he tells us, he has decided to go into teaching because he feels that there is as big a job to do in education as there was in licking the Germans and the Japanese. Unless we revamp our educational processes to fit the needs of the large numbers of people who must be educated for living in a modern society, he maintains, we may get ourselves into a fix. In this, he is in agreement with many of our leading scientists and teachers.

Some people may wonder at a man going into teaching at a time when so many are leaving it. Yet unless we can find more men of Mr. Dyson's type of mind, who sincerely want to make education effective, we *will* be in a fix.

Voice recording has outgrown entertainment field, entered industry . . . Practical, rugged voice recording equipment had to be developed for severest military operating conditions in World War II . . . Now, in the power and industrial plant, voice recorders are available to record such things as telephone communications involving instructions and procedure . . . Details of such use by large power utility . . . Recorders for engineering conferences . . . Value in voice training for those contacting the public . . . Uses in power plant limited only by the imagination of the user of the equipment

cent accurate. It can be used for analysis, study and file. It is just to both the man who initiates the message and the man who receives it.

How a Public Utility Uses Recorders

A typical installation of this kind has been made by the Long Island Lighting Co. A battery of four film-type recorders manufactured by the Frederick E. Hart Corp. has been installed in a cabinet in the power dispatcher's office. These machines emboss the recording on a 35-mm film similar to moving picture film and the resulting recording is available for instantaneous playback without any developing or processing. A voice relay "triggers off" the machine as soon as the phone rings and shuts the machine down when the conversation has been completed. The operation is entirely automatic with the exception of changing the film, an operation which can be completed in a matter of seconds. The resulting two-hour recording is filed under date and time and constitutes a permanent record.

The same machine in the portable state can be used to record engineering conferences. The recording can either be transcribed by a typist and the transcriptions distributed; or the recording may be retained and only such portions played back as are needed to refresh the memory of the participants. Such a recording costs less per unit of recording time than the services of a competent secretary capable of recording conferences. Further, while not so attractive to the eye, it may be more accurate.

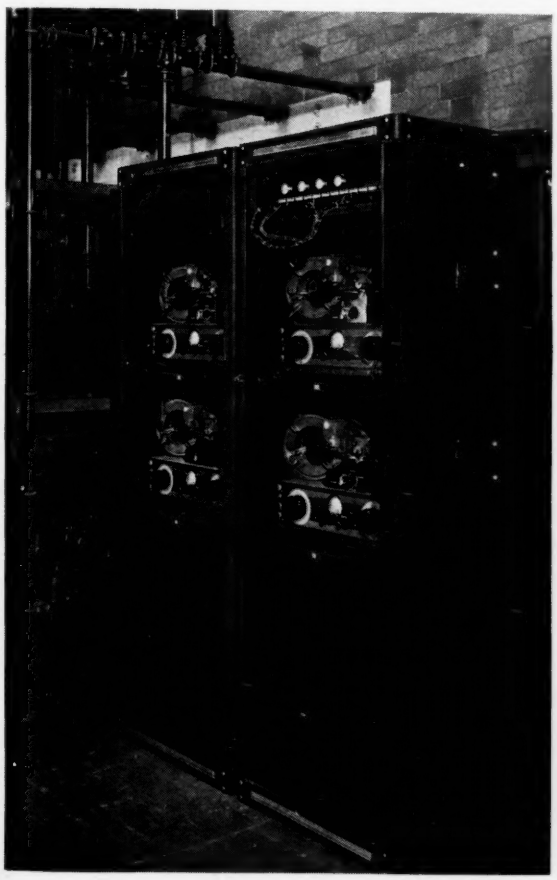


Fig. 2. Close-up of recorders shown in Fig. 1. Operation entirely automatic. Recording embossed on film; playback at once with no developing or processing

Value in Voice Training and Public Relations

In the field of training, recorders can be of inestimable value to public utilities whose very life depends upon good public relations. The average consumer judges a concern by the contacts he or she makes over the telephone. It would seem, therefore, that a continuing program of voice training would pay big dividends.

The very foundation of such a program of voice training is a recorder. Very few people realize how their voices sound to others; very few people realize that their diction is slovenly and their intelligibility poor. This fact can be driven home by a few minutes use of a recorder. A person listens to his own voice and finds how difficult it it to understand himself. Once this fact dawns upon the employee, he becomes actively interested in the problem of improving his speech. Improved public relations inevitably follow.

The magnetic wire or tape recorder admirably serves the purpose of voice training. The recording can be magnetically erased from the wire or tape and the recording medium used indefinitely. The unit cost of training is slight in proportion to the results obtained.

DIMINUTIVE OIL FURNACE TRUNK-SIZE

"A POWERFUL hot-air furnace using combustion principles of the aircraft jet engine will be produced next spring. Although no larger than a small trunk it heats a nine-room house. This great efficiency is achieved by burning fuel oil in a tiny 2½-inch chamber under a walloping thrust of air. If the production models work as well as the two test models now installed in houses, the jet furnace may make most present hot-air furnaces obsolete.

While many postwar products are 1942 models in 1946 clothing, the jet furnace is really new. To deliver an equal amount of heat the new furnace burns 17% less oil than furnaces in current use. It will be called Jet-Heet. Its makers hope to reach a production rate of 10,000 the first year and plan to sell the unit for around $400. This would make Jet-Heet about $175 cheaper than the average hot-air furnace of the same capacity now available.

Rubber-coated flexible glass ducts are used to connect the small round warm air openings of the furnace to specially designed registers in the rooms."

"ANY LAW which can be used to restrict individual professional effort hinders and restrains professional development. No law by which professional employees and those engaged in routine, mental, mechanical and physical work much conform to the same regulatory pattern is a just law. It is unjust alike to the laborer, the non-professional white-collar workers, to the professional man, to their employers, and to society."

GAIL A. HATHAWAY

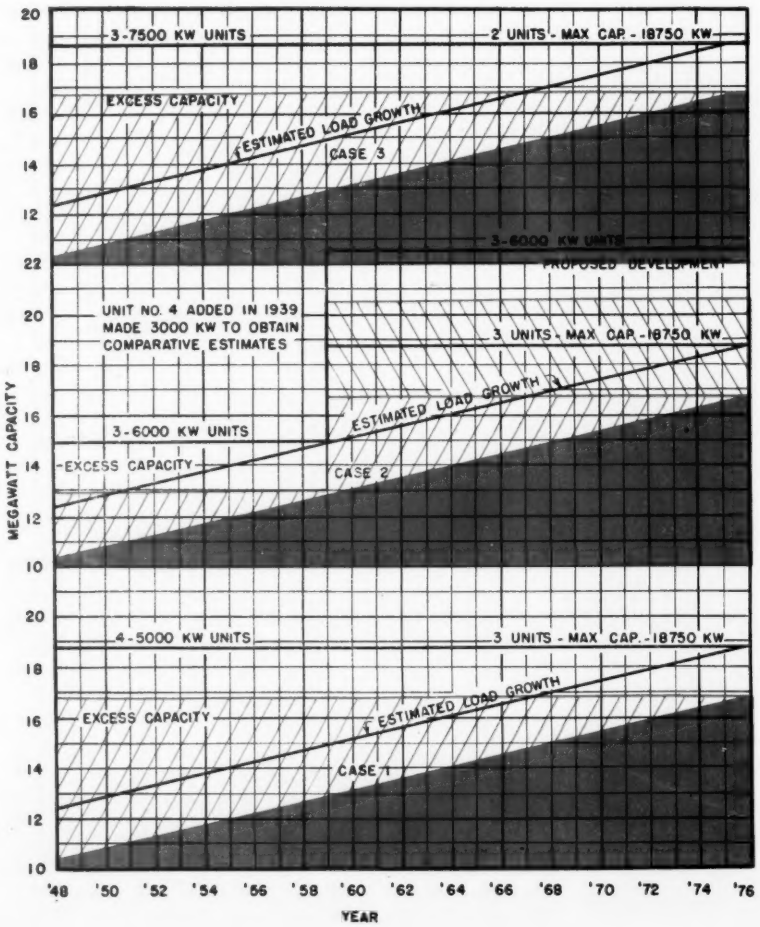
How to Select Units for a Steam-Electric Station

By **C. D. GIBBS**, Louis T. Klauder and Associates, Philadelphia, Pa.

SELECTION of a unit or units for a steam-electric station means the determination of size, steam pressure and steam temperature. The back pressure is usually fixed, within rather narrow limits, by the temperature of the cooling water available at the particular site. The other three features have a much greater latitude and in the end are dependent on the money available, the degree to which future conditions are analyzed and the desire to make a showing. Too often extreme sizes are selected for advertising purposes. Such oversize units carry an unnecessarily large idle investment, or displace the equivalent capacity (frequently the improvement in steam rate justifies this displacement). It must always be kept in mind that a jump in size when a unit is added to a system entails provision of an equal stand-by capacity to cover an outage of this larger unit.

Similarly, steam pressures higher than the economics warrant are frequently used. Many stations have two or three pressures differing only by a relatively few hundred pounds per square inch. Of the many pressures used, only a few are economically justified. This refers to independent units of the condensing type. The topping unit, on pressures of 600 psi or less, is nearly always advantageous; but when topping units are installed, the maximum satisfactory standard pressures and temperatures give the highest efficiencies.

Fig. 1. Comparison of various proposed and selected units with anticipated load, for a specific station under analysis


3-7500 KW UNITS
2 UNITS - MAX CAP. - 18750 KW
EXCESS CAPACITY
ESTIMATED LOAD GROWTH
CASE 3
3-6000 KW UNITS
PROPOSED DEVELOPMENT
UNIT NO. 4 ADDED IN 1939 MADE 3000 KW TO OBTAIN COMPARATIVE ESTIMATES
3 UNITS - MAX CAP. - 18750 KW
ESTIMATED LOAD GROWTH
3-6000 KW UNITS
EXCESS CAPACITY
CASE 2
4-5000 KW UNITS
3 UNITS - MAX CAP. - 18750 KW
EXCESS CAPACITY
ESTIMATED LOAD GROWTH
CASE 1
MEGAWATT CAPACITY
YEAR
'48 '50 '52 '54 '56 '58 '60 '62 '64 '66 '68 '70 '72 '74 '76

Unit Size Depends on Load Conditions and Displaced Units

The size of a unit selected is dependent on the present load, the estimated increase of load in the future, and the relative efficiencies of units to be displaced. Interconnections provide means by which the amount of reserve capacity can be minimized, but consideration of this provision indicates that the problem is then one of a larger system; a system consisting of two or more operating companies. Special features may also be present in interconnections, or even present within one system, such as in limitation of tie capacity or in voltage regulation.

The simplest problem is that of an independent company without interconnections. In this case, the company's station or stations must stand alone. Adequate reserve capacity must be installed to cover what would be the most serious break-down if adequate service is to be maintained. The required installed capacity is then: the peak station load (including auxiliary power) plus the capacity of the largest unit, if the peak load exceeds the peak of the minimum month by more than the capacity of the largest unit. Otherwise the required installed capacity is the peak load of the minimum month (including auxiliary power) plus the capacity of the largest unit (out for maintenance) plus the capacity of the second largest unit (out by breakdown).

Any installed capacity less than that indicated by the preceding formulas will result in a certain hazard to service—a chance taken that a break-down will not occur during those periods when the peak exceeds the capacity of the remaining units.

Influence of Turbine-Generator Overload Capacity

The turbine-generators as manufactured today are given a nominal rating and a continuous overload capacity of 25 per cent. In addition to this, the manufacturers allow around 5 per cent additional steam capacity for regulation and about 3 per cent extra to insure meeting the guarantees. The result is, that the turbine end of the unit has a maximum capacity not less than 135 per cent of the nominal and even more when the vacuum is better than the de-

Size, steam pressure and steam temperature must be determined . . . Load growth, standby capacity required, efficiencies of new and old units, interconnections, excess capacity of units, investment and operating costs and several other factors must be taken into account . . . Back pressure fixed by condensing water temperature . . . Fundamental principles governing selection of units are discussed, then applied to a particular small central station . . . For an estimated load growth from 12,500 kw in 1948 to 18,750 kw in 1976, the most economical choice would be 3 units, each having 6000 kw nominal rating, operating at throttle steam conditions of 600 psi 900 F . . . Analysis of increment costs for three fuel prices . . . Station with these units, using most economical steam cycle, would have normal annual heat rate of 13,230 Btu per kwhr, peak load heat rate of 12,970 Btu per kwhr

sign value. The generator also contains some excess capacity above the 125 per cent built into the unit at unity power factor. Increasing water flow in generator air cooler, or increasing hydrogen pressure in hydrogen-cooled units, permits increasing the generator capacity.

There has been some agitation to revise this practice by limiting the maximum capacity to 110 per cent of the nominal. No matter how the units are rated, there is usually some period in the history of every operating company when they need every kilowatt-hour that the units can generate. For this reason, it is considered the best policy to provide boiler, condenser, and auxiliary capacities adequate for the maximum capacity that the turbine-generator can develop.

As a basis for determining the size of units, experience has shown that three units, each equal to 50 per cent of the peak load at the time of installation, should be evaluated and the two next larger size units should be compared with this. Fewer units (two), each capable of carrying the entire load, result in higher capital investment, half of which stands idle 100 per cent of the time. Also, four or more units result in higher capital investment; although a smaller percentage is idle reserve capacity. It is readily apparent that if the initial installation consists of three 50 per cent capacity units, the fourth would have to be added as soon as there was any increase in load.

How Principles Are Applied To Specific Case

The application of this method of determining the selection is shown in Fig. 1. These data are for an actual system and plant, for which complete designs have been prepared. On this graph, Case I shows the result of installing four 5000-kw units (two for initial load plus one for reserve plus one for growth during the next 28 years). Case 2 shows the result of installing three 6000-kw units initially, and one 3000-kw unit in 1959 (two for initial load plus one for reserve plus the 3000-kw unit for growth after 1959). A 3000-kw unit is used only to evaluate the capacity to 1976; actually the fourth unit would be of 6000-kw. Case 3 shows the result of installing three 7500-kw units (two for initial load, which also handle the growth of load up to 1976). In 1976, each case has exhausted its excess capacity and the installation question is renewed.

The three cases (5000, 6000 and 7500 kw) must next be reviewed to determine the capital investment and interest required up to the time that this problem is renewed in 1976. Preliminary estimates as shown in Table I were made for each of these sizes, assuming a three-unit installation in a building sufficient to house four units.

To evaluate the relative merits of the installations, using three different size units, two basic assumptions have been made. First, that the annual fuel consumption is the same, irrespective of the size of the units. The larger size units have a higher basic efficiency at full load (1976) but, in general, they operate over the entire period with an average load which is at lower percentage of rating and lower basic efficiency. These two features tend to neutralize each other. The second assumption is

Fig. 2. Cost of energy for three assumed fuel costs for station under analysis

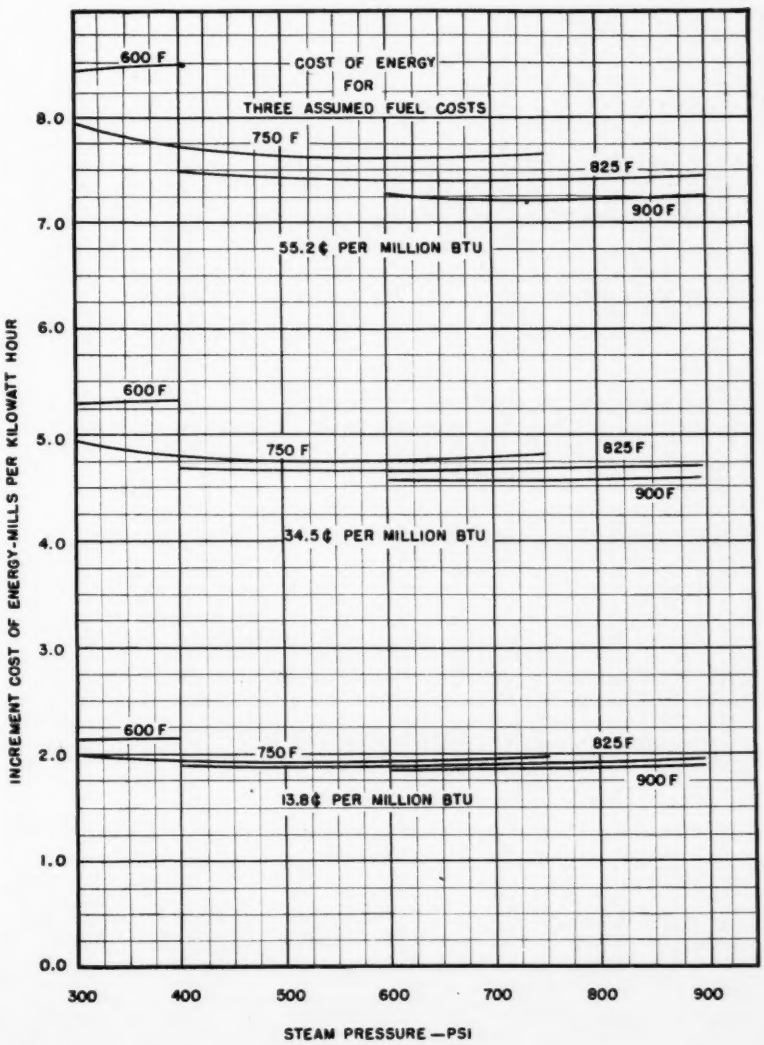


Table I. Preliminary cost estimates for complete power plant, to serve estimated load growth of Fig. 1, comparing three units of 5000, 6000 and 7500-kw capacity each. Values in thousands of dollars

Number of Units and Nominal Rating	3—5000 kw	3—6000 kw	3—7500 kw
Structures & Improvements			
Building including substructure	393	393	393
Grounds and external facilities	47	47	47
Sub-total	440	440	440
Boiler Plant			
Boilers and accessories	490	584	730
Feedwater system	40	42	44
Service water system	14	18	20
Fuel handling equipment	38	40	42
Ash handling equipment	24	26	28
Control equipment	24	24	24
Piping	20	25	30
Miscellaneous	10	11	12
Sub-total	660	770	930
Turbine Plant			
Turbine-generators	360	429	538
Condensers and pumps	100	120	150
Control equipment	36	36	36
Piping	10	11	12
Miscellaneous	4	4	4
Sub-total	510	600	740
Electrical Installation			
Switchgear	40	40	40
Transformers	5	6	7
Conduit and wiring	16	17	18
Control equipment	18	18	18
Miscellaneous	12	12	12
Sub-total	91	93	95
General Plant Equipment			
Crane and other facilities	39	47	55
Total Material and Labor	1740	1950	2260
Direct Field Expense at 13%	226	253	294
Overhead, Engineering, etc. at 9%	177	198	230
Owner's Expense & Contingency	57	59	66
Total Overall Cost	2200	2460	2850
Cost per kw of maximum capacity	$117.25	$109.25	$101.25
Cost of one additional unit	540	620	740
Cost per kw of additional maximum capacity	$ 86.45	$ 82.60	$ 79.00

that the interest rate on the capital requirements is 2 per cent. The resulting cost of investment, over the 28 year period, is as shown in Table II.

The tabulation of Table II indicates that on the basis of equal capacities in 1976, the initial installation of three 6000-kw units will have the lowest initial cost and the lowest total cost by 1976. Actually, another 6000 kw unit would be installed in 1959 and the date required for the fifth unit would be extended to 1995, instead of 1976, as indicated by a 3000-kw unit installation shown in Fig. 1, Case 2.

The above dates are predicated upon a rate growth established by a preliminary report. Should this rate growth be higher than anticipated, the dates required for new units would be advanced. The conclusions would remain unaltered; the initial cost and the ultimate cost are minimum for the 6000-kw size unit.

How to Determine Steam Pressure and Temperature

Having established the size of unit to be used, the remaining problem is to determine the steam pressure and steam temperature to be used by these units, operating at an average back pressure of 1.5 in. Hg absolute. To evaluate the various pressures and temperatures available for this size unit, it is necessary not only to make estimates of that part of the installation affected by changes in pressure or temperature, but also to determine the auxiliary power required and the overall efficiency of the station.

To do this, it is necessary to arbitrarily select a sufficient number of pressures and temperatures and to calculate the performance and estimate the cost of each. The turbine manufacturers have established certain breakpoints in turbine prices where casing construction or steel alloys change. These breakpoints are tabulated as in Table IV.

Obviously the pressures and temperatures selected for calculation should be the maximum for each particular class; otherwise the cost of the next higher pressure or temperature is incurred without the attending improvement in efficiency.

For the 6000-kw unit selected as the proper size for the proposed station, the pressures chosen for calculation were: 400, 600 and 900, with 300 and 750 psi included as a matter of interest; and the temperatures selected were: 750, 825 and 900 F, with 600 F included for the two lower pressures.

Items Affected By Pressure and Temperature

An estimate was made of those items of the station which were affected by the pressure and steam temperature. The 300-psi, 750-F selection gave the lowest estimate, and this was subtracted from each of the others to obtain the increase of capital cost resulting from the selection. The fixed charges on this increased cost were taken at 10 per cent, (5 per cent depreciation, 4 per cent interest, and 1 per cent insurance and taxes). These fixed charges, representing the annual cost of the capital required by the pressure and temperature selected, were added to the fuel cost for one year's operation and this in turn was reduced to the cost per kilowatt hour of plant output. The resulting adjusted increment costs are shown in Table III, for two assumed fuel costs.

It will be noted that in each of the pressures calculated, the highest temperature selected resulted in the lowest adjusted increment cost. It will also be noted that for a given temperature, the cost decreases with increase of pressure up to 600 psi, and increases slowly at

Table II. Capital and interest requirements for complete power plant of Table I, for three sizes of units

Number and size of units	4—5000 kw	3—6000 kw	3—7500 kw
Initial Capital Investment	$2,740,000	$2,460,000	$2,850,000
Interest, 1948 to 1959	602,800	541,200	627,000
Investment in 1959	0	310,000	0
Interest, 1959 to 1976	931,600	941,800	969,000
Capital and Interest to 1976	$4,274,400	$4,253,000	$4,446,000

Table III. Adjusted increment costs in mills per kilowatt-hour for various steam conditions

Assumed fuel cost in cents per million BTU	13.8c	55.2c
300 psi — 600 F steam	2.13	8.45
300 psi — 750 F steam	1.98	7.90
400 psi — 600 F steam	2.15	8.49
400 psi — 750 F steam	1.94	7.75
400 psi — 825 F steam	1.88	7.48
600 psi — 750 F steam	1.93	7.61
600 psi — 825 F steam	1.90	7.43
600 psi — 900 F steam	1.86	7.27
750 psi — 750 F steam	1.97	7.65
750 psi — 825 F steam	1.93	7.46
750 psi — 900 F steam	1.87	7.20
900 psi — 825 F steam	2.04	7.85
900 psi — 900 F steam	1.89	7.27

Table IV. Manufacturers' breakpoints in turbine prices where casing construction or steel alloys change

Maximum Throttle Pressure	Maximum Steam Temperatures, Degrees F			
400 psi	750	825	900	950
600 psi	750	825	900	950
900 psi *	750	825	900	950

* Condensing units for this pressure are furnished in sizes of 3000 kw and larger, but the lower pressures apply to all sizes from 500 kw upward.

still higher pressures, except for the 750 psi at 900 F temperature, which, for the high fuel cost, shows a slight decrease.

Figure 2 shows the relation of increment cost to the steam pressure for the four selected temperatures. These curves show that the choice of pressure should be from 600 to 750 psi; and that choice of temperature should be 900 F.

This study, therefore, has resulted in establishing the following for the proposed station:

Number of Units	3
Nominal Rating of a Unit	6000 kw
Throttle Steam Pressure	600 psi
Steam Temperature	900 F

A station having units of the above rating, and utilizing the most economical steam cycle, would have approximate heat rates of 13,230 Btu and 12,970 Btu per kwhr for annual operation and peak load respectively.

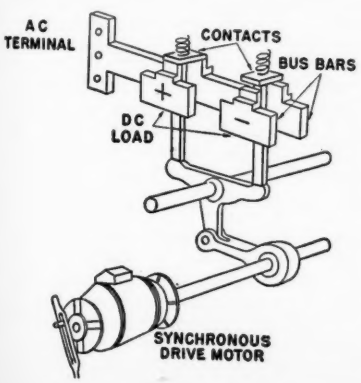
Contact Rectifiers

The synchronous mechanical rectifier is one of the oldest types of devices for converting alternating current into direct current, yet it is the one that has received the least practical application in this country. It is therefore of great interest to learn that in Germany, during the war, this type of rectifier was developed to a high degree of efficiency and effectiveness. Efficiencies of 99 per cent were attained

A synchronous mechanical rectifier developed in Germany during the war changes alternating current into direct current much more efficiently than the mercury arc rectifiers, rotary converters, and motor-generator sets used in the United States. Called the "contact rectifier," it attains an efficiency as high as 99 per cent at one-quarter to full load.

It proved a boon to German electrochemical industries requiring large direct currents at low safe voltages. Plants engaged in electroplating, aluminum extraction, chlorine manufacture, and other electrolytic processes used it at a saving not only in operating and maintenance cost but also in plant space.

The I. G. Farbenindustrie, Germany's omnipotent chemical cartel, installed various models in its branch factories. For example, its Heydebreck branch contained four rectifiers, each capable of supplying 8,000 amp at 400 v; and its Bitterfeld branch had two rectifiers, each rated at 9,000 amp for 90 to 180 v.



A simple form of contact rectifier

Contact rectifiers were equally successful, in electro-welding, charging small storage batteries, and generating traction power. Hamburg streetcars operated with 1,500 amp at 600 v supplied by a contact rectifier.

In 1943, the Siemens-Schukert Co. of Berlin—the company that perfected the contact rectifier—built a model capable of delivering 10,000 amp at 400 v, or 5000 amp at 800 v, and, by the end of the war, had designed rectifiers with outputs of 60,000 kw.

The American electro-chemical industry appears particularly interested in rectifiers efficiently producing 10,000 to 15,000 amp at 300 to 600 v. A study of the Siemens products and the methods of manufacture may provide the "know-how" for developing advantageous American adaptations.

One simple form of contact rectifier mechanism consists of two contacts mounted on either end of an arm which both rocks and vibrates up and down. The up-and-down motion, driven by an eccentric from a synchronous motor, moves the contacts to make and break the circuit. The rocking motion, also controlled by an eccentric in synchronism with the phase of the alternating current, selects each contact alternately. In a complete cycle of operation, two contacts are made: when the alternating voltage is positive, one contact connects it to the positive side of the direct current line; when the voltage swings negative, the other contact makes the circuit to the direct-current negative terminal. Thus positive current is always delivered to the positive direct-current terminal and negative current to the negative. The result is a undirectional current.

The use of saturated nickel-iron choke coils in the alternating current feed lines virtually eliminates backfires, or arcing, when the contacts make and break connections. Even in the rare event of an arc, the damage is very small. A circuit breaker switches out all contacts in about $\frac{1}{100000}$ second limiting the injury of the shorted contact and completely protecting all others.

The metallic nature of the contacts provides the best medium for conducting an electric current. A silver-plated copper contact can easily handle a current density of a thousand amperes per square centimeter—many times the capacity of a brush of a rotary converter or the mercury capor of a mercury arc rectifier. A contact rectifier requires less construction material, and weighs less than a quarter pound per kilowatt output at full load.

The high conductivity of the contacts helps minimize the energy dissipated in converting alternating current to direct current. According to German data, a contact rectifier furnishing 2500 kw loses only about 25 kw—less than one-fourth as much as a rotary converter of equal output. In terms of conversion efficiency it reaches 99 per cent, or 3.6 per cent more than the rotary converter. To large industrial consumers of direct current, increases in efficiency of even less than 1 per cent may mean a great saving in production costs.

At the Ludwigshaven plant of the I. G. Farbenindustrie, contact rectifiers maintained an efficiency of 97 to 98 per cent during 5 years of operation.

Even small units apparently excelled other types of rectifiers. For example, a 7 kw contact rectifier for charging batteries operated at an efficiency of 90 per cent—10 to 20 per cent higher than other types.

In addition to its greater efficiency and smaller weight, the contact rectifier offers the advantage of low maintenance cost. Unlike the rotary converter, it has no large rotating parts, brushes, commutators, and slip rings. Unlike the mercury arc rectifier, it needs no vacuum-tight joints, nor such auxiliary equipment as vacuum pumps and complicated firing circuits.

Its moving parts are simple and light, and easily accessible for replacement and repairs.

ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

What is Nuclear Energy?

Why is nuclear energy so different from other forms of energy man has used? . . . Implications of Radioactivity . . . Chemical Energy . . . Why Carbon Dioxide? . . . The Fundamental Nature of Nuclear Energy . . . Binding energies . . . Why light Nuclear reactions are ruled out for power . . . Operation of a Nuclear Reactor . . . The complete annihilation of matter . . . The significance of radiation from outer space

By **ANDREW W. KRAMER**, Managing Editor, Power Plant Engineering

SEVERAL DAYS AGO a reader of this magazine wrote a letter asking for advice concerning his plans for the future development of his power plant. Expressing interest in the various articles on atomic energy which have appeared in this section, he wondered whether, in making plans for the growth of his power plant, he should give serious consideration to the possibility of utilizing atomic energy.

Though his concern in this respect is premature—I assured him that as far as industrial power plants are concerned he need not worry about atomic energy in the near future—it would be better if there were more people like him; people in ordinary pursuits of life who really are concerned about atomic energy, whether for war or for peace. Too many people feel about atomic energy the way they feel about the national debt—something sinister that hangs over their heads but that somehow will work itself out.

Like the reader just mentioned, most of those who read this magazine are perhaps more interested in the production of power from atomic energy than in the problem of the atomic bomb, and rightly so because, after all, power is our common problem, our bread and butter. We cannot, however, separate the problem of atomic power from the atomic bomb; the principles controlling the one also control the other, and, unless we solve the problem of the atomic bomb, it may avail us little to develop power from nuclear energy. The practical possibility of developing atomic power it must be remembered arose from the research and development that produced the atomic bomb.

It is difficult for many of us to realize how different, how new, and how powerful nuclear energy is from anything we have ever known. Until recently, that is until the discovery of radioactivity in the early years of this century, there were only three kinds of forces that man knew of; 1. the gravitational force which holds the world together and which governs the motions of the planets and stars, 2. electrical force, exhibited by the attraction of amber when rubbed for small bits of paper, and 3. magnetic force, exhibited in the natural magnetism of the lodestone. For many centuries these were the only forces man had discovered.

Now, in the phenomenon of nuclear energy, we have a fourth force—the force which holds the nucleus of the atom together. This force is at once the most powerful, the most universal and the most elusive force man has discovered. Since it is inherent in all the atoms of which everything, animate or inanimate, is made, it surrounds us on all sides, yet, until recently, its existence was never even suspected.

Nuclear physics had its origin in the discovery of radioactivity. The natural phenomenon of radioactivity brought into being an entirely new science, one owing its allegiance neither to physics nor to chemistry as these sciences were understood before radioactivity was discovered by Becquerel in 1896. Radioactivity was concerned with a knowledge of elementary atoms themselves, so fundamental and so intimate, that the old laws of physics and chemistry did not suffice. The old laws of physics and chemistry were almost wholly concerned with the external relationships of the atoms whereas radioactivity, it appeared was concerned with the relationship of elements within the nucleus of the atom itself. Until that time knowledge of chemistry and physics had been growing rapidly but the discovery of radioactivity showed how very superficial our knowledge of matter had been.

Radioactivity was the most startling, the most incomprehensible, the most upsetting discovery ever made in science. If one were to demonstrate to an architect or builder that the bricks he had always used in the construction of his structures were, under other circumstances, capable of entirely different uses—say, for example, that they could be used as explosives incomparably more powerful than dynamite or TNT—the surprise of the architect or builder could have been no greater than the surprise of the chemist at the new and undreamed of possibilities of matter demonstrated by the mere existence of

ATOMICS

an element such as radium. For, in radium, we have an element evolving a perennial supply of energy year after year without stimulus and apparently without exhaustion. The mysterious radiations from radium seemed to upset the very law of the conservation of energy.

In time, however, the nature of radioactivity became known. It was found that the enormous and seemingly inexhaustible energy manifested by radioactive materials came from the nucleus of the atom itself. In this respect it proved entirely different from chemical activity. Chemical energy arises from the forces which exist between the *external* elements of the atoms, that is, between the systems of electrons which surround the nuclei of the atoms. Atomic energy is energy arising from forces which exist between the *internal* elements of the atom, that is between the protons and neutrons which compose the nucleus of the atom. These *nuclear* forces which hold the protons and the neutrons together are enormously greater than the forces which hold the external electrons together; therefore, the energy release from nuclear reactions is enormously greater than the energy release from chemical reactions, that is, from rearrangements of the electronic configurations of the different atoms.

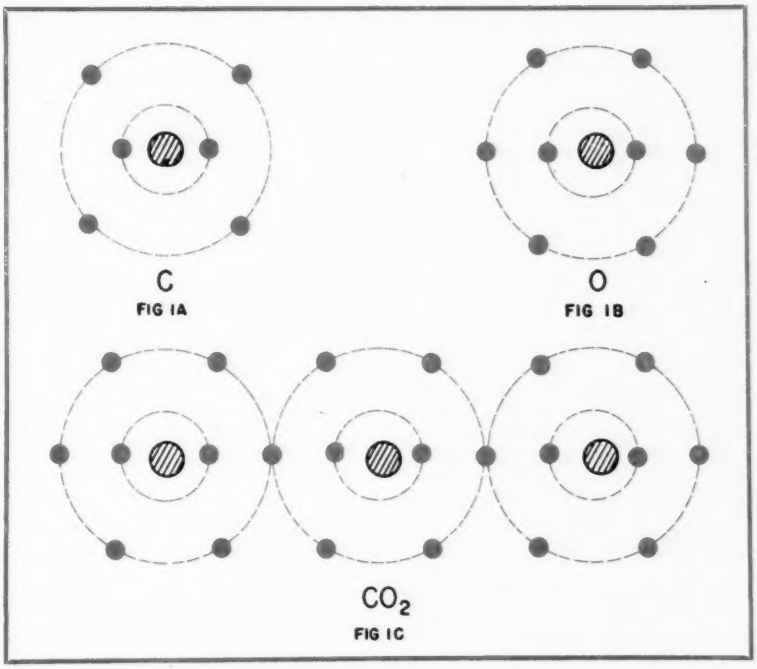


Fig. 1. Atomic structure of (A) the carbon atom; (B) the oxygen atom, and (C) the carbon dioxide molecule

Chemical Energy

Chemical energy is available because the electrons of some of the elements are more tightly bound to the atom than are others. If, in the reaction between two systems, the resulting system is more tightly bound together, that is, there is less potential energy available, the reaction is said to be exothermic, and energy will be released. Thus, in the combustion of coal, carbon atoms combine with oxygen atoms to form the more stable carbon dioxide, and energy is released. This is shown in Fig. 1A. The carbon atom consists of a nucleus surrounded by a total of six electrons disposed in two orbits. The inner orbit can contain no more than two electrons and this is true whether an atom has only a single orbit as in the case of Helium or whether it has seven orbits with 80 or 90 electrons; the innermost orbit will never have more than two electrons. This orbit is fully *satisfied* when it has two electrons.

Since the carbon atom has a total of six electrons in the two orbits and since there can be only two electrons in the inner orbit, this means that the second orbit has four electrons. This also is shown in Fig. 1A. The second orbit, however, requires eight electrons to form a stable system. Since the carbon atom has only four electrons in this second orbit, it tends to satisfy its electron requirements by combining with other atoms to form more stable systems.

The oxygen atom also consists of a nucleus surrounded by electrons disposed in two orbits but the oxygen atom has a total of eight electrons, two in the inner orbit as with carbon, but with six electrons in the second orbit. Thus the oxygen atom lacks two electrons in the second orbit to form a stable system of eight. The oxygen atom, therefore, also tends to combine with other atoms to form more stable systems.

Why Carbon Dioxide?

Now it becomes apparent why a carbon atom combines with two oxygen atoms to form a molecule of carbon dioxide—CO_2. The outer orbits of two oxygen atoms have $2 \times 6 = 12$ electrons. The carbon atom has four electrons in its outer orbit. Hence when two oxygen atoms combine with one carbon atom to form a molecule of CO_2, we have $(2 \times 6) + 4 = 16$, which is equal to 2×8, that is, to two orbits of 8 each. Thus, as shown in Fig. 1C the CO_2 molecule has the equivalent of two fully satisfied *second* electron orbits.

The forces between atoms are electrical, since they are due to the electric fields of the electrons. When an atom lacks a few electrons of forming a stable system, it is said to be electronegative. When it has a few more electrons than the number needed for a stable system, the atom is said to be electropositive. An oxygen atom, for example lacks two electrons in the second orbit, hence, it tends to combine with atoms having more electrons than that required for a stable system. It must be remembered that the number of electrons which any atom can have depends upon the number of protons in the nucleus, the number of external electrons is always equal to the number of protons in the nucleus. Thus, ordinary hydrogen with only a single proton as the nucleus, has one external electron. Uranium, on the other hand, with 92 protons in the nucleus, has 92 external electrons. If electrons are temporarily removed from an atom as by rubbing a stick of sealing wax, the character of the atom does not change since the number of protons in the nucleus remains the same. In this state, however, the atoms are said to be ionized—electrified—and they will tend to recapture the lost electrons.

As explained, oxygen with six electrons in its second orbit is electronegative. Carbon, however, has four electrons in this second orbit. Thus carbon is midway between 0 and 8 and so it will as readily part with electrons as acquire them, that it is will tend to combine with other atoms having either more or less than the number of electrons required for stability. Hence, carbon is a very active element, it enters into all organic reactions.

This is all that needs to be said here about the nature of chemical energy. The combination of oxygen with carbon in the process of combustion is typical of many thousands of reactions. Since there are 92 separate elements, each one capable of combining with numbers of others it is apparent that an all but endless number of combinations is possible. The attraction that one element has for another is known as the valence force and these forces lie at the base of the whole great field of chemistry.

Now, let us consider nuclear energy.

ATOMICS

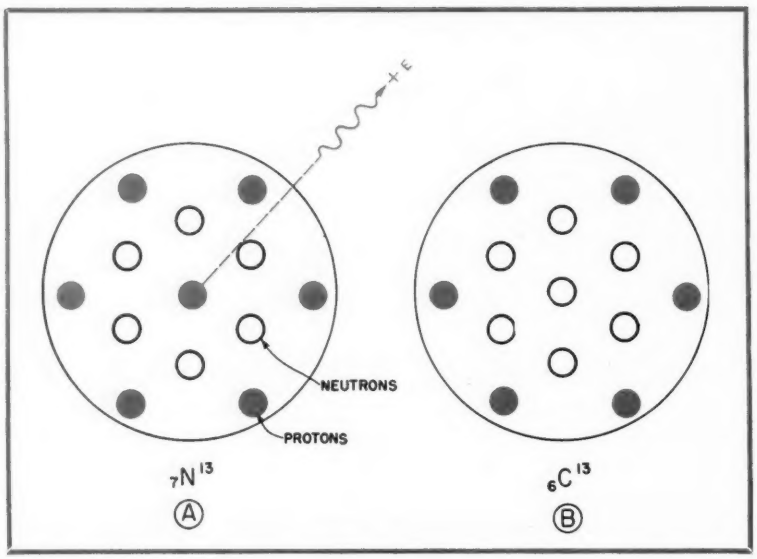


Fig. 2. Showing the transmutation of nitrogen 13 into carbon 13 by the emission of a positive electron

In somewhat the same way that chemical energy results from the combination of external electronic systems, so nuclear energy results from rearrangements of neutrons and protons in the nuclei of the atoms. The number of possible arrangements of nuclear groups is far less than with atomic grouping since there are only two fundamental particles available, the proton and the neutron. Moreover, there are nuclear reactions called beta radiation reactions in which either one of the two elements can be converted into the other so that, in a sense, there is only one element involved. A neutron for example, is converted into a proton by the emission of a negative electron. Similarly, a proton is changed into a neutron by the emission of a positive electron. This action is shown when boron, $_5B^{10}$ is bombarded with helium $_2He^4$. The reaction that takes place is shown by the equation

$$_5B^{10} + {}_2He^4 \rightarrow {}_7N^{13} + {}_0n^1$$

In this equation, the symbol $_0n^1$ represents a neutron. Thus, boron and helium react to form nitrogen 13 and a neutron. Nitrogen 13, however, is not found in nature and it is unstable. It changes into stable carbon $_6C^{13}$ by emitting a positive electron. Thus,

$$_7N^{13} - (+e) \rightarrow {}_6C^{13}$$

What really happens in this reaction is that one of the neutrons in the nucleus of the nitrogen atom changes into a proton by the emission of the positive electron, +e. Figure 2 shows the reaction graphically. At A is shown the unstable $_7N^{13}$ nucleus. It consists of 7 protons and 6 neutrons. Now, with the one exception of hydrogen 3, no nucleus of any atom is stable that contains more protons than it does neutrons. Since $_7N^{13}$ has one more proton than it has neutrons it is unstable. Therefore, one of the protons changes into a neutron by the emission of a positive electron. This produces the $_6C^{13}$ carbon nucleus which has 6 protons and 7 neutrons.

Binding Energies

This process of changing one element into another is very different from the formation of chemical compounds by combining different elements. It is called *transmutation*, and, as was shown, it is a *nuclear* reaction. The example chosen is only one form of several types of nuclear reaction. The fission of U-235 by slow neutron capture is another. Also the formation of a helium nucleus by combining 4 hydrogen nuclei [1] is another. As was explained in a previous article [1] when 4 protons (hydrogen Nuclei) combine to form a single helium nucleus there is a slight loss of mass. This mass (0.03 mass units) represents the *binding energy* of the protons and neutrons in the helium. It looks small but remembering the Einstein equation $E = MC^2$ where C is the velocity of light, this small mass loss represents a great deal of energy, equal to 190,000 kilowatt-hours per gram of helium! This is the amount of energy that would be released if we could assemble a single gram of helium nuclei from slightly more than a gram of hydrogen nuclei. We cannot do it on earth but the process goes on naturally in the sun.

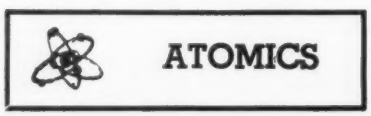
There are a great many things about the combination of protons and neutron in the nuclei of atoms that we do not understand and the nucleus of the atom may be more complex than we know now but we do know that the forces which exist between the protons and the neutrons are very great. What their nature is we do not know. If they are electrical, they behave very differently than do ordinary electrical forces. Just what part the neutron plays is not clearly understood but neutrons seem to be necessary to keep protons together. Carrying a positive electrical charge, protons naturally repel each other in accordance with the inverse square law, and at the distances they are from each other in the nucleus of the atom, the repulsive force would be enormously great if no other factors were present. Actually, there is a great attractive force which *binds* the elements of the nucleus together and the neutron seems to play an important role in establishing these binding energies. The fact that no nucleus is stable that has more protons than neutron seems to prove this.

Despite the lack of accurate knowledge of absolute nuclear structure at present, we can define "atomic energy" as arising solely from differences in nuclear binding energies in the same way that chemical energy arises from differences in molecular binding energies.

The very fact that the nuclear binding forces are so great makes it difficult for us to bring about their release. In nearly all exothermic reactions, it is necessary to put in a certain small amount of energy before the stored energy in a system is released. Thus in the combustion of coal it is necessary to raise the coal to the kindling temperature before the combustion of the coal starts. In the same way, the stored energy in a stick of dynamite or TNT will not be released until we put a certain small amount of energy in, either by raising the temperature or by subjecting the material to a sharp blow.

As was pointed out, protons carry electrical charges which repel each other. The closer two protons come together the more they will repel each other and at extremely short ranges these electrical forces become relatively enormous. Since the nuclear forces which constitute the *binding energies* in the nucleus apparently do not begin to act until the protons are brought very close together, it is clear that the electrical forces must be overcome before the nuclear forces can act. See Figs. 3 and 4. This, then constitutes the great difficulty—the problem of supplying enough force to first overcome the electrical repulsive force. This is why cyclotrons are necessary in bombardment experiments. They are machines for imparting great force to electrically charged particles so that they can overcome the repulsive electrical forces. By accelerating protons and other charged particles to such high velocities that they are not completely stopped by the electrical repulsive forces existing at close range, they can be made to approach other nuclei close enough so as to permit the nuclear forces to pull them together.

While we can attain such forces by means of the cyclotron and other accelerating devices, their practical



[1] See Eee Equals Em See Squared, February 1947, pages 80 to 85.

efficiencies are very small because only relatively few of the nuclei in a given "target" are actually hit. Most of the high speed particles waste their energies in passing through the external electronic orbits of the atoms. What is needed is a method of bringing a large number of nuclei very close together, and, as explained in a previous article [2] this, it seems can only be done by raising the entire mass of atoms to temperatures of millions of degrees and at the same time subjecting them to enormous pressures—the conditions which prevail in the interior of the sun and stars.

Light Nuclei Reactions For Bomb But Not For Power

The necessity for these high temperatures and pressure compel us to rule out the possibility of utilizing the nuclear energies released by rearrangements of the light nuclei as far as "power" is concerned. No vessel or material arrangement that we can think of could contain such temperatures and pressures, even if we could produce the temperatures. As pointed out by W. G. Pollard [3] "for the practical operation of such *nuclear fires* here on earth we may set as a minimum requirement a temperature of at least a million degrees Fahrenheit and a pressure of several million atmospheres. These requirements are based on the simple fact that all atoms have positively charged nuclei and thus no special or devious technical development which by-passes them can be expected. The problem is essentially one of activation energy."

The fact that these temperatures and pressures rule out the possibility of utilizing the reactions of light nuclei for "power" purposes does not imply that they cannot be utilized in an atomic bomb. An atomic bomb of the uranium or plutonium type actually produces momentary temperatures and pressures well above these required to ignite a number of light element reactions and it is not beyond the bounds of possibility that a combination of the uranium fission reaction and light element reaction may produce the super-atomic bomb of the future. If this combination is achieved it brings us face to face with a threat to our future existence such as man has never faced before.

It is for this reason people, particularly engineers should be concerned about atomic energy. Atomic energy is the most powerful force in the Universe. Yet knowledge of it goes back only a few years. All that we know of it was discovered in the lifetime of a person less than 52 years old today. That is hard to believe—it is fantastic. But what is still more fantastic is that about 90 per cent of what we know of this all pervading force, was discovered during the last 15 years. Chadwick only discovered the neutron in 1932, and it was 1934 when Curie and Joliot produced artificial radioactivity!

Ever since Becquerel discovered radioactivity in 1896, scientists realized that there were vast forces within the structure of the nucleus of the atom and they tried to find ways of releasing it. They wondered whether it could be released but until Hahn and Strassman produced fission in uranium no one *knew* whether it could be released. Then, they knew it and they set about to establish a nuclear chain reaction. When they built the first "pile" at the University of Chicago what they thought would happen actually did happen. As was stated in a previous article in this section, December 2, 1942 will be marked as one of the most important dates in the history of man for it was on that date that the first sustaining nuclear reaction was produced. On that day, we learned that atomic energy could be let loose and that its release could be controlled. True, this was but a step on the way to the production of the atomic bomb—it was incidental as far as the bomb was concerned but now, this chain reactor provides us with a pattern for the atomic power plant.

Operation of Nuclear Reactor

Consider such a reactor. It is very simple. It consists merely of a large block of very pure graphite in which regularly spaced parallel holes are drilled. In these cylindrical holes smaller cylindrical uranium rods are centered so that a cooling medium—water, gas, or molten metal can be circulated in the annular space between the rods and the inside walls of the holes. Atomic fission takes place in the uranium rods. When a slow neutron is captured by a U-235 nucleus, the latter splits into approximately two equal parts. These fission fragments, barium, krypton, iodine, etc., fly apart at inconceivable velocity but being large they are stopped, for the most part, in the uranium rods where they are produced. Since these fission products are generated at temperatures of *thousands of millions* of degrees, the absorption of this energy in the rods results in an intense heating of the rods, hence the necessity for the cooling medium and an efficient transfer of heat from the rods to the cooling medium. After coming to thermal equilibrium with the uranium metal the fission fragments, which are atomic *nuclei*, collect the right number of electrons to become normal atoms lodged in "solution" in the metal. These fission products, however, are unstable—they have more protons than neutrons in their nuclei. Therefore, they undergo a whole series of radioactive disintegrations before reaching a stable condition. These disintegrations give rise to gamma rays which, because of their penetrating nature are not absorbed by the metal rods but pass out to be absorbed in the moderator (the graphite) or in the massive radiation shields which surround the pile. Several per cent of the total energy released in the pile is in the form of this gamma radiation.

When an atom of uranium splits in addition to the fission products, that is, the barium, krypton, etc., single neutrons are also liberated. These are fast neutrons and they are produced at a steady rate in the metal at a temperature of some 10,000 million degrees, F. They represent a very dilute but hot gas which diffuses out into the moderator where it is cooled by mixing to the temperature of the moderator. As a cool gas it diffuses back into the metal rods where it can produce more fissions.

Thus, a nuclear reactor though simple in construction represents a complex mixture of conductive, convective and radiative heat transfers and a great deal of development will have to take place before they can be built into an actual power plant. As indicated above, how-

[2] *Ibid.*
[3] Educational implications of the Utilization of Atomic Energy for Power. By W. G. Pollard. ASME Spring Meeting, April 1946.

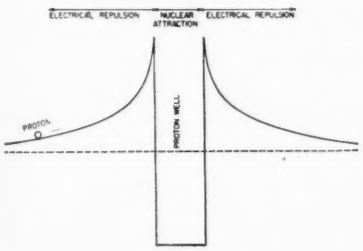


Fig. 3. A proton potential well. This diagram attempts to show how the forces acting upon a neutron change when it approaches to within a very short distance of the nucleus of an atom. Up to a certain very small distance from the nucleus, the proton is repelled by the electrical force in accordance with the inverse square law. It is as though the proton were a ball rolling up an incline which become increasingly steep as it approaches the lip of the well. The closer it comes the greater the repulsion. If the proton has enough kinetic energy so as to reach the lip of the well, it will suddenly roll in and fall to the bottom. This represents the nuclear attractive force.

The reverse also is true. If a proton at the bottom of the well should be given enough force to raise itself to the level of the lip of the well, it may roll out and thus be ejected from the nucleus of the atom

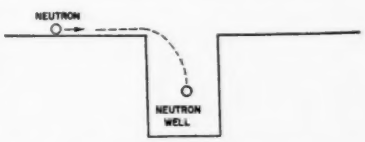


Fig. 4. This diagram shows a neutron well. This diagram has the same significance as the one in Fig. 3 except that it represents the conditions for a neutron approaching the nucleus of an atom. The neutron is not electrically charged, hence, it is not opposed as it nears the nucleus. Thus, if the neutron happens to be headed in the right direction it will simply roll into the well. It may bounce out of the well again unless there is some good reason for its "capture"

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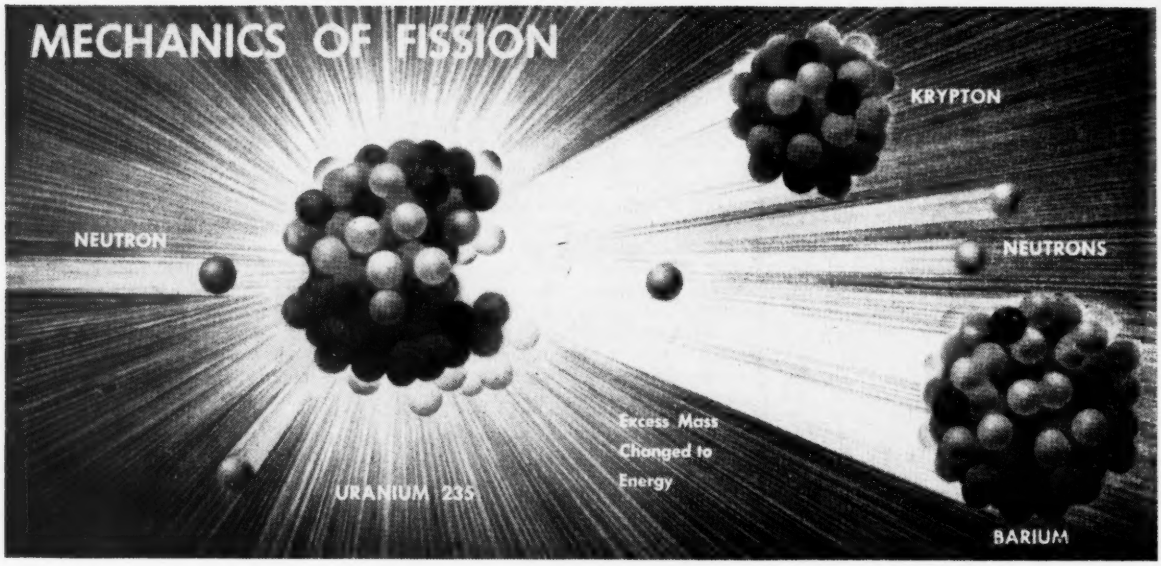

Fig. 5. The mechanism of nuclear fission

ever, nuclear physics is just in its infancy. The first wave of researchers, the fundamental scientists have found the new energy and shown that it can be used. They have made a beginning—only a beginning. The second, third and fourth wave of attackers; the applied scientists, the engineers and the other technicians, will find new methods of putting the new energy to use. They will also find new ways for putting it to destructive use. This, however, is not particularly the scientist's problem. The scientists function is to discover and invent. What use man may put his discoveries to is the problem of society. There are people who wish, now, that nuclear energy had never been discovered. This view is childish. Nuclear energy is a part of nature; its discovery was as inevitable as fire. It may be that the world is confronted with a difficult and nasty problem but that is the way life is. We can't spend our time looking backward. Atomic energy is a challenge to society and if society is to survive it will have to meet this challenge.

The Einstein Equation Again

In the reactions considered thus far, only the "binding energy" of the nuclear elements is involved. The release of the binding energies, however, accounts for only a very small part of the total energy in the nucleus of an atom. The release of the binding energy marks the disappearance of a small amount of mass. Suppose, however, that the entire mass of the nucleus was converted into energy in accordance with the Einstein equation, what power would be released? When a U-235 bomb explodes, the explosion products of 1 lb of U-235 weigh 0.990 lb. In other words, 0.001 lb or $\frac{1}{10}$ of one per cent of the mass is converted into energy and this produces 11½ million kilowatt-hours of energy. Suppose however that the entire 1 lb mass of U-235 was converted into energy; then the energy output of that pound of U-235 would be over eleven thousand million kilowatt-hours!

The question arises, is such a reaction possible? Can matter be completely annihilated? It appears possible. In certain nuclear investigations it has been found that when an electron encounters a new strange particle known as the mesotron (sometimes called the meson) a nearly complete annihilation results. Little is known about the mesotron however. In cloud chamber experiments, particles (or radiation impulses) with enormous energies seem to be arriving continually on the earth from outer space in the form of cosmic rays and these aparently are capable of knocking mesotrons out of the nuclei of atoms. These mesotrons are very short lived. Their half life seems to be somewhere between 1 and 2 *microseconds*. Their appearance seems to indicate that the structure of the nucleus is more complex than we now suppose it to be but until we are capable of building cyclotrons and accelerating devices very much more powerful than the ones we now have, we cannot expect to produce mesotrons in considerable number. The fact that radiation of such high energy levels as are necessary to produce mesotrons come from outer space seems also to indicate that incredibly violent reactions, far greater than the nuclear reactions we know of, can, and do, occur in nature spontaneously. There is still much to be learned. Some day when the supercyclotron is built we will know more about these things. In the meantime uranium fission is about all that the human race can safely cope with.

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PENNSALT ANNOUNCES $3,500,000 POWER IMPROVEMENTS

THE PENNSYLVANIA Salt Manufacturing Co. announced it now has under construction at its Wyandotte plant additional boilers and allied power generating equipment, including a completely new modern power plant building, at a cost of more than $3,500,000.

In addition to new equipment, Pennsalt is installing fly ash collectors for the present three large pulverized-coal burning boilers at an estimated cost of $200,000. The new boilers also will be equipped with the fly ash collectors. These collectors, made by the Western Precipitation Corp., will remove solid products of combustion in the flue gases in an amount equal to or better than existing municipal requirements.

In the existing boilers the company now is installing new induced draft fans and new motors to take care of the additional draft loss placed on the boilers by the fly ash collecting equipment in the duct system through which products of combustion are discharged. Steel superstructure for the fly ash collecting equipment on the present boilers has been erected and this part of the project will be completed and in operation before the end of this year.

The new boilers and power equipment will be completed during 1948, it was said. The actual combustion space of these new boilers has been designed to permit use of the lower grade coal which is the only grade now obtainable. These boilers will have a higher steaming capacity than the present ones and will generate steam at pressure and temperature levels which will add to the overall efficiency of operation of the steam power facilities.

Engineers and constructors for the new plant and equipment are Ford, Bacon and Davis, Inc., of Philadelphia and New York.

The Gas Turbine Power Plant — V

By **JOHN I. YELLOTT**

Director of Research, Locomotive Development Committee, Bituminous Coal Research, Inc.

The gas turbine prime mover itself, analyzed in detail . . . Fundamental principles and calculations as they apply to any type of turbine . . . How to calculate performance, air velocities, blade speed, power, efficiency of single impulse stage . . . Principles of the reaction turbine; calculations for air velocities, blade speed, power, efficiency for this type . . . How blade stresses and dimensions may be estimated . . . How to calculate design and performance factors for 4000-hp gas turbine . . . Labyrinth glands important to prevent air leakage . . . How to figure turbine air rate . . . Construction details of various types of gas turbines . . . Provisions for utilizing high turbine inlet temperature and cooling turbine parts . . . This part continues the first authoritative textbook on how to design and build a gas turbine power plant today . . . Metals available to meet gas turbine requirements, how they can be used, existing gas turbine power plants, including those supplying steam, will be covered in Parts VI and VII

THE TERM "gas turbine" can be applied to any prime mover of the turbine type in which the working fluid is a permanent gas such as air rather than a vapor such as steam. In design and construction the gas turbine closely resembles the familiar steam turbine although there are important differences in such matters as operating temperature, magnitude of pressure drop, rotative speed, and materials of construction. Turbine theory is well explained in the standard text books, such as those listed at the end of this section. The treatment in the present article will be limited to a discussion of those factors which are particularly important in the gas turbine power plant.

Fundamental Principles of All Turbine Types

A few relatively simple laws of mechanics and thermodynamics describe the over-all performance of all types of turbines. The law of impulse and momentum relates the force exerted upon a turbine nozzle or bucket to the change in fluid momentum which that element causes:

$$F \Delta t = (W \div g) \Delta V \qquad (1)$$

Here F is the force in pounds imparted when a certain weight of fluid, W, undergoes a change in velocity, ΔV (feet per second) in a time interval Δt (seconds). The product of the force F and the time interval Δt is known as "impulse," while the product of fluid mass, $(W \div g)$, and velocity change is the magnitude of the change in the fluid's momentum.

One of the most striking applications of this law is found in the behavior of a jet-propelled airplane. A turbo-jet unit that takes in 100 lb of air per second and expels it through the tail pipe with a velocity relative to the plane of 1000 fps, creates a force or thrust of

$$F = (100 \div 32.2) \times 1000 = 3100 \text{ lb}$$

If the plane is flying at 375 mph, the continuous exertion of this thrust would represent 3100 hp.

Pure reaction devices, such as the jet that powers a high-speed plane, find only limited usefulness in other fields. The oldest turbine recorded in history is the pure reaction type, similar in principle to the lawn sprinkler or pinwheel. No such turbines are now in use, because of practical problems of capacity and efficiency. Power turbines are usually a combination of the impulse type, in which all the pressure drop takes place in the fixed nozzles, and the reaction type, in which some or most of the pressure drop occurs in the moving blades. A brief analysis of the characteristics of each type is in order here.

The Impulse Turbine

Figure 1 shows a typical single impulse stage, such as that used in turbo-superchargers, turbo-jet plants, or other applications where a high pressure drop per stage, with high rotative speed, is wanted. The efficiency of a simple impulse stage is largely dependent upon the ratio of the blade speed, V_b, and the gas speed, V_2. The velocity of the gas leaving the fixed nozzles, V_2, is found from the general energy equation for steady flow:

$$h_1 + V^2_1 \div (2g \times 778) = h_2 + V^2_2 \div (2g \times 778)$$

$$\text{or } V_2 = 223.7\sqrt{(h_1 - h_2) + (V^2_1 \div 50{,}000)} \qquad (2)$$

The actual change in enthalpy of the gas passing through the nozzle must be used in (2), but this can be related to the isentropic or ideal change in enthalpy, Δh_s, by the use of the nozzle efficiency, E_n, and the nozzle velocity coefficient, C_n.

$$(h_1 - h_2) = E_n \times \Delta h, \qquad (3)$$

$$V_2 = C_n \times \text{theoretical velocity} \qquad (4)$$

Consider a single-stage turbine in which air at 1500 F, 1960 R, 30 psia, approaches a nozzle ring with an initial velocity of 100 feet per second. From the *Gas Charts*,[1] $h_1 = 398.4$ Btu per lb, relative pressure = 332.14 psi. If the air expands to atmospheric pressure in the nozzles, the new relative pressure will be $(14.7 \times 332.14) \div 30 = 163$ psi, and the conditions following

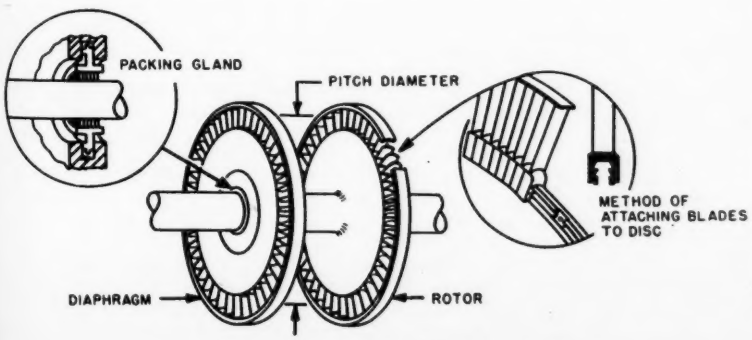

Fig. 1. Construction details for a typical impulse stage

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Part I, January, 1947 issue covered general principles, preliminary performance calculations, cycles and equipment, comparison of gas turbine and steam plants.

Part II, February issue, gave detailed calculations, diagrams and charts for figuring performance of plant and components.

Part III, April issue, gave calculations for design of plant components; compressors, duct-work, combustors and the like.

Part IV, May issue, gave complete details of combustor design and performance because of importance of combustor in practice.

[1] POWER PLANT ENGINEERING, February, 1947; page 75.

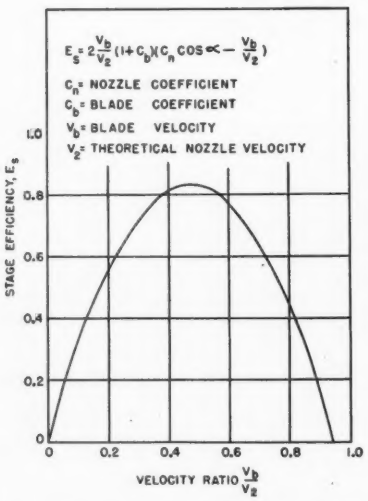
$E_s = 2\frac{V_b}{V_2}(1+C_b)(C_n \cos\alpha - \frac{V_b}{V_2})$
C_n = NOZZLE COEFFICIENT
C_b = BLADE COEFFICIENT
V_b = BLADE VELOCITY
V_2 = THEORETICAL NOZZLE VELOCITY
STAGE EFFICIENCY, E_s
VELOCITY RATIO $\frac{V_b}{V_2}$

Fig. 2—Above. Stage efficiency vs. velocity ratio for a single-row impulse stage

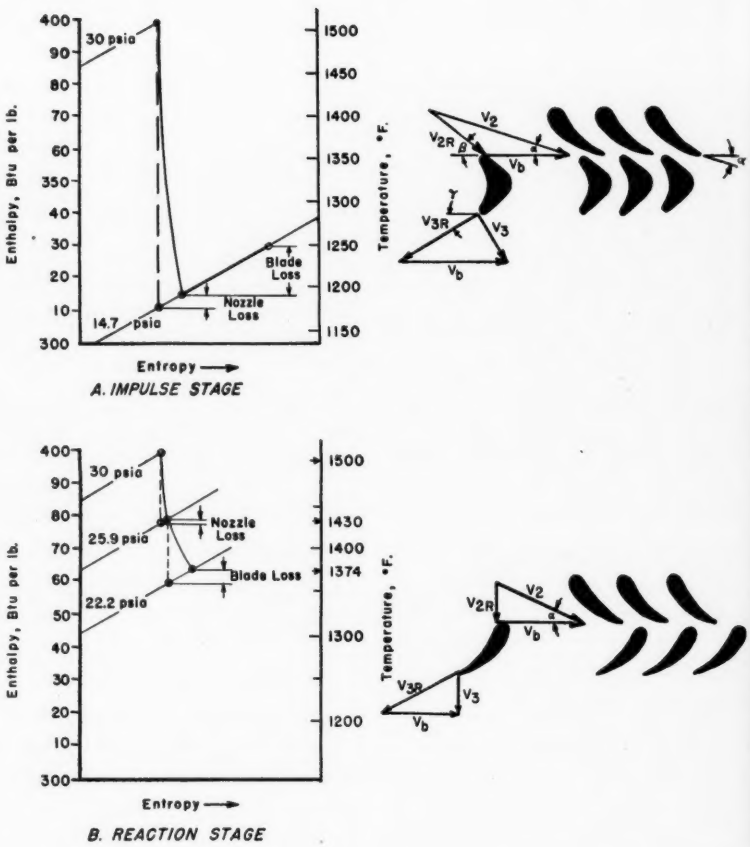

Fig. 3—Right. Comparison of impulse and reaction stages; h-s and t-s diagrams, velocity diagrams, and element profiles

the isentropic expansion would be: $h_2' = 310.8$ Btu; $T_2' = 1638.6$R, $t_2' = 1179.0$F. If the nozzle were perfect, the exit velocity would be:

$$V_2 = 223.7\sqrt{(398.4-310.8)+(100^2 \div 50{,}000)}$$
$$V_2 = 2080 \text{ fps} \quad (5)$$

If the nozzle velocity coefficient is assumed to be 0.97, the actual velocity would be $0.97 \times 2080 = 2020$ fps. The velocity of approach is usually negligible in a single-stage turbine. The efficiency of the nozzle, E_n, can be shown to be equal to the square of the velocity coefficient, or, in this case, 0.94. Hence, the actual nozzle outlet conditions, neglecting the small velocity of approach, will be:

$$h_2 = h_1 - E_n \times \Delta h_s = 398.4 - 0.94 \times 87.6 = 316.4 \text{ Btu per lb} \quad (6)$$

$T_2 = 1659.6$ R; $t_2 = 1200$ F

It should be noted that the expansion through the nozzle has lowered the temperature of the air by approximately 300 F, so the rotating blades will not be entered by excessively hot air.

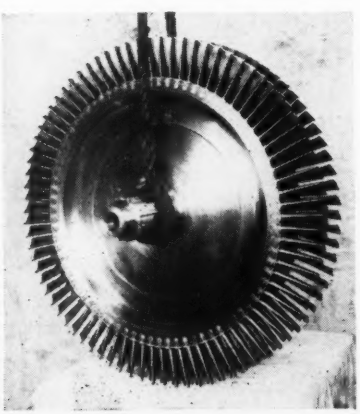

Fig. 4—Left. Two-stage gas turbine wheel, showing twisted blades and the method of attaching them to the wheel. (Courtesy Metropolitan-Vickers Electrical Co., Ltd. and R. T. Sawyer)

The relation between the air velocity, V_2, and the blade speed, V_b, controls the efficiency with which the kinetic energy in the high velocity air stream is converted into work by the moving blades. For the case where the blade angles at inlet and outlet, β and γ, are equal, and the nozzle outlet angle, α, is 12 degrees, the relation between stage efficiency and velocity ratio is given by Fig. 2. It can readily be shown that the maximum stage efficiency exists when $V_b \div V_2 = \text{Cos}\alpha \div 2$. Since the nozzle outlet angle α is always made as small as possible, Cos α is nearly unity, and so the optimum velocity ratio is approximately 0.5.

Continuing the example, the blade speed V_b should be about $2020 \div 2$ or 1010 fps. At this point, the turbine designer must establish the rotative speed at which his unit is to run, for he must have a product of stage diameter and rpm which will cause V_b to approximate the optimum value.

$$V_b = \pi \times \text{diameter} \times \text{rpm} \div 60 \quad (7)$$

The steam plant turbine designer is often confronted with the necessity of providing a turbine to drive an alternator. Hence he usually selects a rotative speed that will give him 60-cycle current with a four-pole or two-pole alternator. The gas turbine may also have to operate at 1800 or 3600 rpm, but a single-stage turbine of the type under consideration would be more likely to use a much higher speed, such as 6000 rpm. Using this value,

$$V_b = \pi \times \text{diameter} \times 6000 \div 60 = 1010 \text{ fps} \quad (8)$$

Diameter = 3.22 ft = 38.5 in.

To carry the example still further, assume that the air flow is 100 lb per

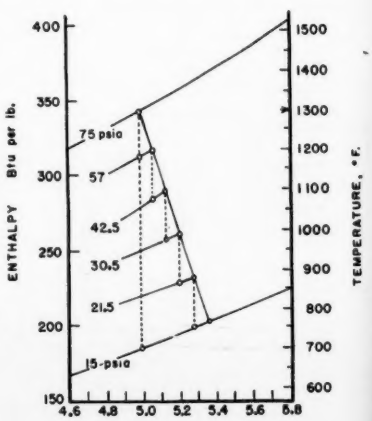

Fig. 5—Right. h-s Diagram for a five-stage reaction turbine

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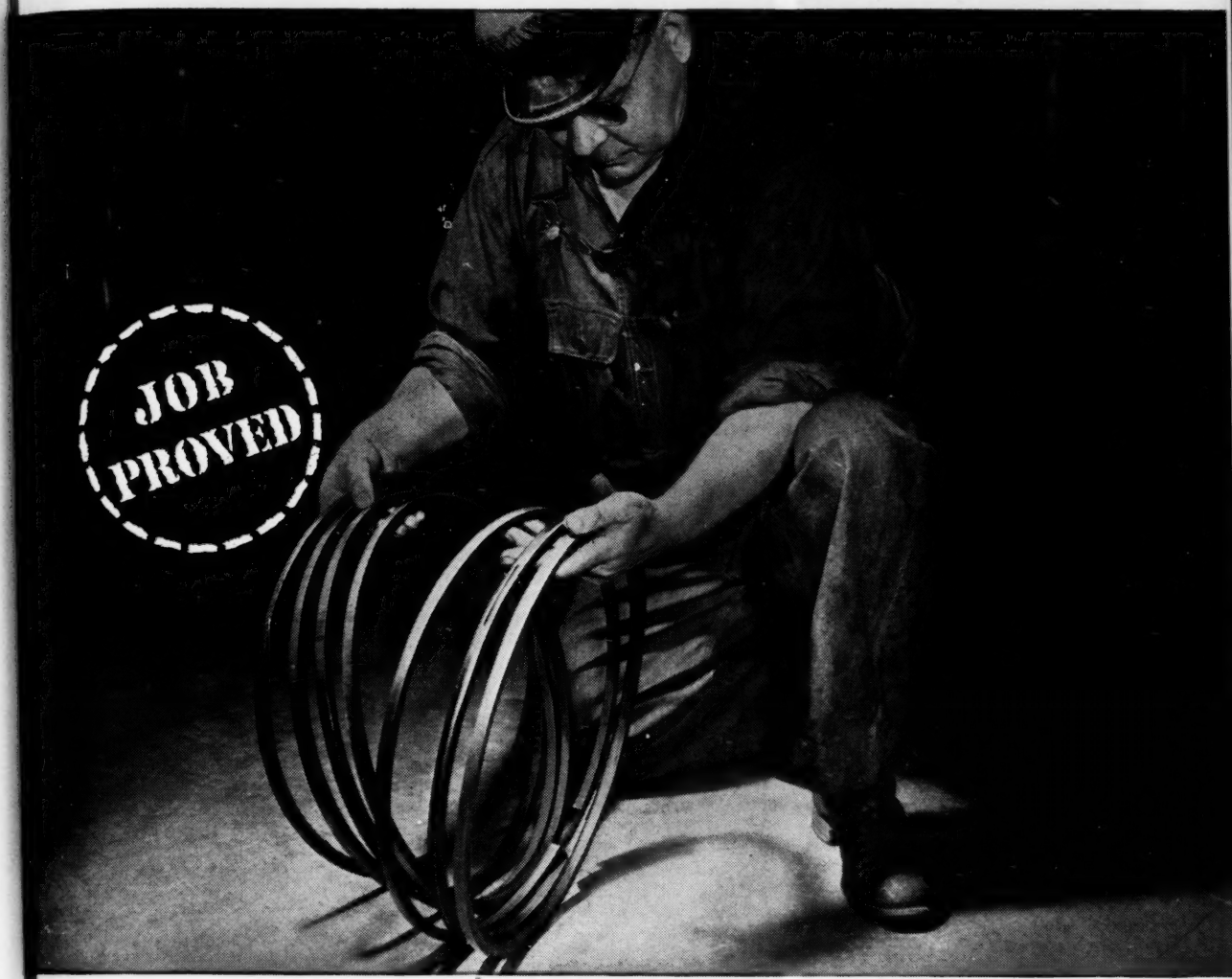

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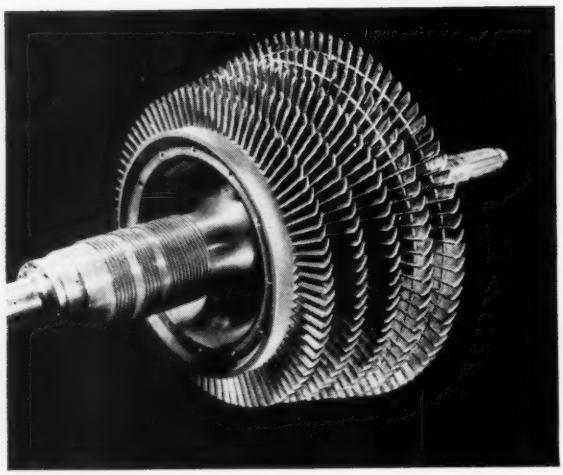

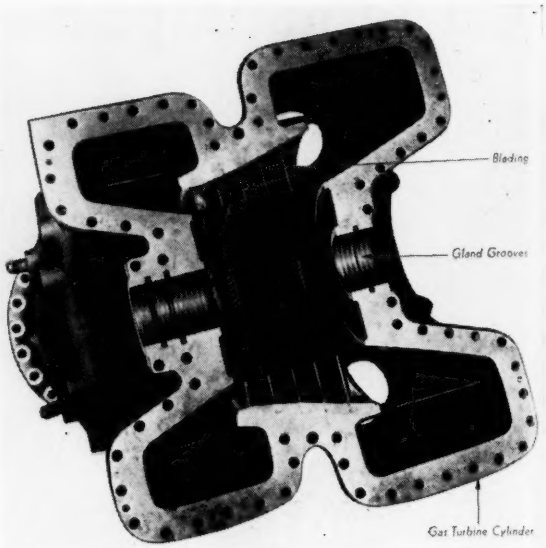

Fig. 6—Left. Rotor of a five-stage Allis-Chalmers gas turbine, 6600 hp, 5180 rpm, for conditions similar to Fig. 5
Fig. 7—Right. Cylinder for the five-stage Allis-Chalmers rotor shown in Fig. 6

second. The specific volume at the nozzle outlet condition of 14.7 psia, 1200 F, 1659.6 R, is:

$$V_2 = 0.37 \times 1660 \div 14.7 = 41.8 \text{ cu ft per lb}$$

The volume of air to be handled per second is 100 lb × 41.8 cu ft per lb = 4180 cu ft. The height of the blades can be estimated from the flow relation: cu ft per sec = annulus area × velocity, where the velocity component perpendicular to the annulus is employed.

$$4180 = \pi \times \text{pitch diam} \times \text{blade height} \times \text{Sin } \alpha \times 2020 \quad (9)$$

$$4180 = \pi \times 3.22 \times \text{height} \times 1 \times 2020$$

$$\text{blade height} = 4180 \div (\pi \times 3.22 \times 1 \times 2020) = 0.203 \text{ ft} = 2.44 \text{ in.}$$

If a higher rotative speed had been selected, the pitch diameter would have been smaller, and the blade length greater.

The gas turbine designer deals with much larger volumes at the inlet end of the turbine than does the steam designer, since steam plant pressures are far higher than those encountered in the open cycle gas turbine.

To complete the numerical example, the efficiency of the impulse stage in question can be expected to be about 82 per cent. The energy actually extracted would be $(2020 \div 223.7)^2 \times 0.82 = 68$ Btu per lb. The enthalpy and temperature of the air leaving the stage would be: $h_2 = 398.4 - 68 = 330.4$ Btu per lb; $T_2 = 1710$ R; $t_2 = 1250$ F. The exit velocity would be $223.7 \sqrt{14} = 845$ fps. The power at the turbine shaft would be:

Power = 3600 × 100 lb per sec × 68 Btu per lb ÷ 2545 = 6200 hp. If the exit velocity is conserved and directed into a jet, the kinetic energy which would otherwise be wasted can be used for propulsive effort. In the foregoing simplified analysis, the effect of disk friction, leakage, and similar losses has been neglected.

The behavior of a single impulse stage can be summarized in the following terms. For a given rotative speed and stage diameter, an impulse stage will extract a maximum amount of energy from a flowing stream, and it will produce the maximum temperature drop. It will not, however, produce the highest attainable efficiency. In aircraft units, where lightness is of paramount importance, single-stage turbines are used, similar to the unit which has just been developed. Very high inlet temperatures can be employed because of the large temperature drop in the nozzles.

Principles of Reaction Turbine

In the case of a reaction stage, the pressure drop, and hence the change in enthalpy, is divided between the nozzles and the moving blades. The percentage of the total stage energy drop which occurs in the moving blades is often called the "percentage of reaction." A stage in which the energy drop is equally divided between the fixed and moving elements is termed a "50-per cent reaction stage."

Because of the wide variety of combinations which can exist in reaction stages, it is not easy to establish a simple relation between efficiency and velocity ratio such as that which exists for an impulse stage, Fig. 2. However, for a 50-per cent reaction stage, the highest efficiency results when the ratio $V_b \div V_2 = \text{Cos } \alpha$, or when the blade speed is approximately equal to the steam speed.

To utilize again the numerical example which has been used for the simple impulse stage, consider again the case in which 1500-F air enters a stage at 100 fps, and 30 psia. The isentropic enthalpy change to the discharge pressure, 14.7 psi, is 87.6 Btu per lb, but it will be assumed that only 50 per cent of the available energy will be used in the nozzles. The velocity leaving the nozzle, assuming $C_n = 0.98$ (a slightly higher value is used than for the impulse nozzle because the velocity is lower) is:

$$V_2 = 0.98 \times 223.7 \sqrt{87.6 \times 0.50 + (100 \div 223.7)^2} = 1450 \text{ fps} \quad (10)$$

In order to utilize this air speed with highest efficiency, the blade speed would have to be 1450 fps also. Either the rotative speed or the stage diameter would have to be increased by almost 40 per cent above the values previously established for the impulse stage.

Reaction Stage Efficiency

Using the same blade speed, 1010 fps, as the impulse stage, the reaction stage can use an enthalpy drop of $(1010 \div 223.7)^2 = 20$ Btu in the nozzle, and another 20 Btu in the blades. The total energy which can thus be extracted by a turbine of comparable dimensions is thus about twice as great for an impulse stage as for a reaction stage. In steam-turbine service, this merely means that a reaction turbine would have about twice as many stages as an impulse turbine for the same operating conditions. In a gas turbine, however, it is often desirable to reduce the temperature of the air or gas as rapidly as possible, and in such cases an impulse stage or two are used, followed by several reaction stages. In general, reaction stages show a higher efficiency than impulse stages. The velocity-compounded impulse stage, often used in steam practice, is almost never met in gas turbines.

The major limitation on the amount of energy which can be extracted from the working fluid in a stage is the centrifugal stress that the blade root can withstand. Returning to the numerical example, the single-stage impulse turbine calls for a 2.4-in. blade height with a pitch diameter of 3.22 ft at 6000 rpm. The root diameter would be 3.02 ft, and the root blade speed would be: $\pi \times 3.02 \times 6000 \div 60 = 950$ fps, while the tip speed would be $\pi \times 3.42 \times 6000$

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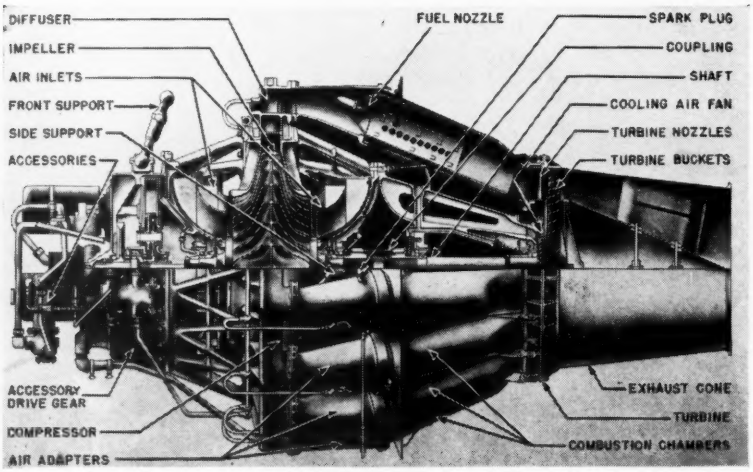


Fig. 8. Cutaway of the General Electric I-40 aircraft gas turbine with double-inlet impeller and "straight-through combustor"

$\div$ 60 = 1170 fps. This variation in blade speed along the radial height of the blade is responsible for the fact that such blades are usually twisted, in order to give the proper exit angle all along their length. Figure 4 shows a two-stage turbine wheel.

The centrifugal force acting at the root of the blade, which weighs, W_b pounds, will be:

$$F_c = W_b \div g \times (950^2 \div 1.51) = W_b \times 18{,}500 \quad (11)$$

A very rough estimate of the unit stress at the base of the blade can be obtained from the following computation. The weight of the blade, W_b, assuming that the blade material weighs 0.28 lb per cubic inch will be:

$$W_b = \text{length, (inches)} \times \text{area, (in.}^2\text{)}, \times 0.28 \quad (12)$$

centrifugal stress, $S_c = F_c \div$ area

$$S_c = \text{length} \times \text{area} \times 0.28 \times 18{,}500 \div \text{area} \quad (13)$$

Since the area cancels out the approximate centrifugal stress is

S_c = length $\times$ 0.28 $\times$ 18,500 = 3.22 $\times$ 5170 = 16,700 psi

Since this blade operates at a temperature of 1200 F, it is apparent that the upper limit of stress has been reached, if not exceeded.

Calculations for 4000-hp Reaction Turbine

Evidently, if a large energy drop is to be utilized in a turbine, a number of stages must be used. Consider a 4000-hp turbine in which the heated air enters at 75 psia, 1300 F, and exhausts at 15 psi. From the *Gas Charts*, at T_{r1} = (1300 + 460) = 1760 R, h_{r1} = 343.6 Btu per lb, and the relative pressure is 216.1. After isentropic expansion to the exhaust pressure of 15 psia, the relative pressure would be 216.1 $\times$ 15 $\div$ 75 = 43.2, the enthalpy h'_{r2} would be 184.7, and the temperatures would be 1155.6 R, 696 F. The isentropic change in enthalpy would be Δh_s = (343.6 — 184.7) = 158.9 Btu per lb.

In view of the previous discussion on allowable energy drop per stage, it would appear to be desirable to use five reaction stages, with an approximate heat drop of 32.8 Btu per lb in each stage. The stage efficiency can be estimated at about 87 per cent, so the first stage would produce 0.87 $\times$ 32.8 = 28.6 Btu of work on the rotor per lb of air and the enthalpy at the stage outlet would be 343.6 — 28.6 = 315.0 Btu per lb.

Referring to the Mollier and temperature-entropy diagram, Fig. 5, the approximate condition of the air at the end of each stage can be seen. Because the losses in the first four stages are not entirely wasted but are in part available for use by the following stages, the total amount of available energy for the turbine as a whole is greater than the 158.9 Btu per lb that were ideally available from the isentropic expansion. The ratio of the sum of the individual stage heat drops (Δh_{ss}) to the originally available enthalpy change is called the "reheat factor." In the case of this particular turbine, the reheat factor is about 1.03. The internal efficiency of the turbine is higher than the efficiency of an individual stage:

$$E_i = \Delta h_a \div \Delta h_s \quad (14)$$

The amount of energy actually given to the rotor by all of the stages is called the internal work, Δh_a. The kinetic energy corresponding to the absolute velocity, V_3, leaving the last row of blades is not recoverable, and it is called the "leaving loss." The actual enthalpy of the air exhausted from the turbine is

$$h_{r2} = h_{r1} - (\Delta h_a + \text{leaving losses}) \quad (15)$$

The internal work, Δh_a, must be corrected for the bearing friction and any other mechanical losses, such as lubricating oil pump work, which must be performed from the turbine shaft. These losses rarely exceed 1 per cent or 2 per cent of the shaft power.

Reaction Turbine Power and Efficiency

The actual shaft horsepower which the turbine produces is

$$\text{Shaft Power} = (W_g \times \Delta h_a) \div 2545 - \text{Mech. Losses} \quad (16)$$

The over-all efficiency, E_T, which is usually called the "engine efficiency" in steam practice, is defined by the equation:

$$E_T = (\text{Shaft Power} \times 2545) \div (W_g \times \Delta h_s) \quad (17)$$

Where Δh_s is the energy ideally available for the turbine per lb of working fluid, and W_g is the amount of working fluid in lb per hr,

$$W_g = W_a + W_f - (\text{Leakage, etc.}) \quad (18)$$

Where W_a is the weight of air taken into the compressor per hour, W_f is the weight of fuel supplied per hour, and (Leakage, etc.) represents the sum of the gland leakage, unburned fuel, ash

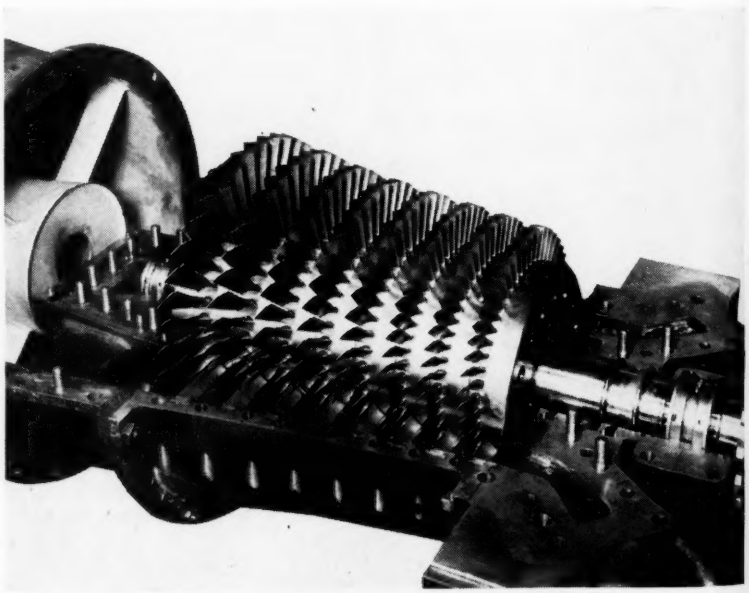
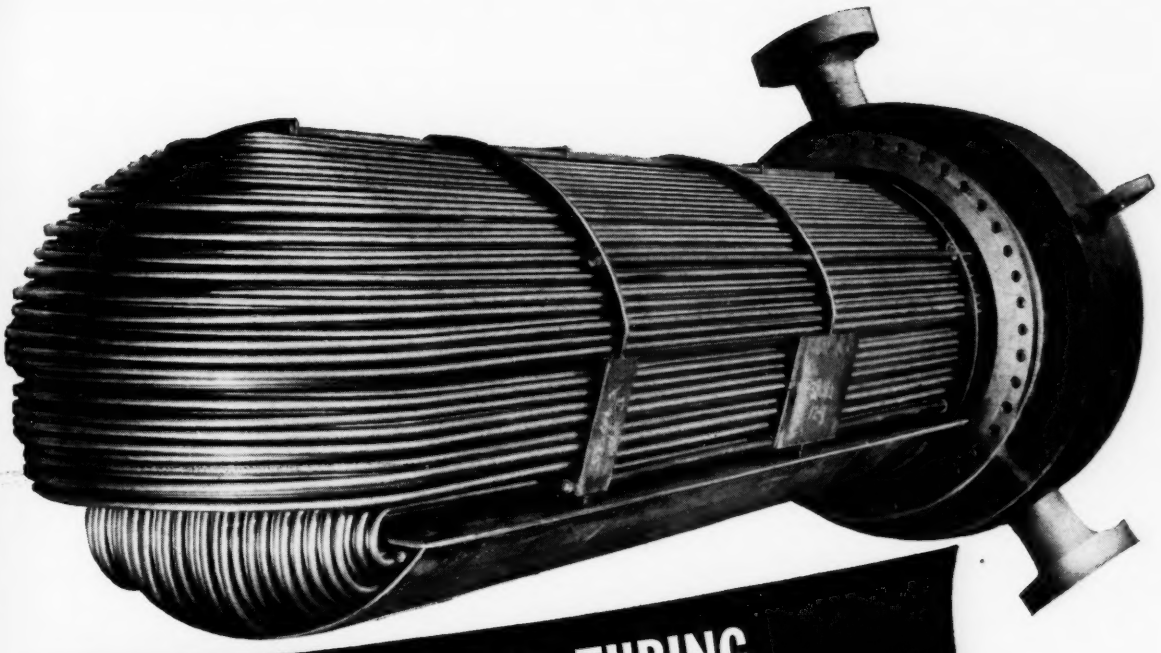


Fig. 9. Rotor of the Westinghouse 2000-hp gas turbine, with the upper half of the casing removed



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which may be separated out, air used only for cooling which does not work, etc.

Importance of Labyrinth Glands

The labyrinth glands which are used to minimize leakage around the turbine shaft deserve special consideration. At the high pressure ends of the compressor and the turbine, there is obviously an opportunity for the compressed and heated air to leak out around the shafts. It is not possible to use a conventional type of packing because of the high shaft rotative speed. Hence the air leakage cannot be absolutely prevented, but it can be reduced to a very small amount by using a series of baffle rings which leave only a small clearance between the shaft and the casing. By making the rings thin, and using a number of them, the leakage area is held to a minimum, and the multiplicity of restrictions produces, in effect, a very low flow coefficient for the area which must exist. The usual steam turbine practice of bleeding sealing gas into the glands can be used when it is desirable to replace with cooler air the hot gas which would otherwise escape. Leakage between the stages of a turbine is minimized by using labyrinth-type seals to reduce the opening between the stationary and moving elements.

How to Figure Turbine Air Rate

To return to the matter of turbine performance, the turbine air rate can be defined as the weight of air (the working fluid is usually considered for simplicity to be ordinary air) supplied per turbine shaft horsepower.

$$\text{Turbine air rate} = 2545 \div (\Delta h_a \times E_T) \quad (19)$$

In the numerical example being considered previously, E_T would be about 86 per cent, then turbine air rate $= 2545 \div (158.9 \times 0.86) = 18.6$ lb per hp hr.

If the working fluid is a gas other than air, the isentropic enthalpy change, Δh_a, can be calculated from the fundamental equation:

$$\Delta h_a = 144 \times p_1 v_1 \times k \left[1 - (p_1 \div p_2)^{(1-k) \div k}\right] \div [778 \times (k-1)] \quad (20)$$

Greatly simplified methods for using this equation and for obtaining values of k, the isentropic exponent, for a number of gases are given [2] by Goldsbury and Henderson.

Care must be used not to confuse the "turbine air rate" with the "plant air rate," since the turbine must supply both the net plant power output and the compressor power requirement: Equation (19) shows the quantity of air needed to generate one horsepower hour at the turbine shaft, but the amount of air needed for a horsepower hour of net plant output must be found from:

$$\text{Plant air rate} = W_a \div (\text{Turbine power} - \text{Compressor power}) \quad (21)$$

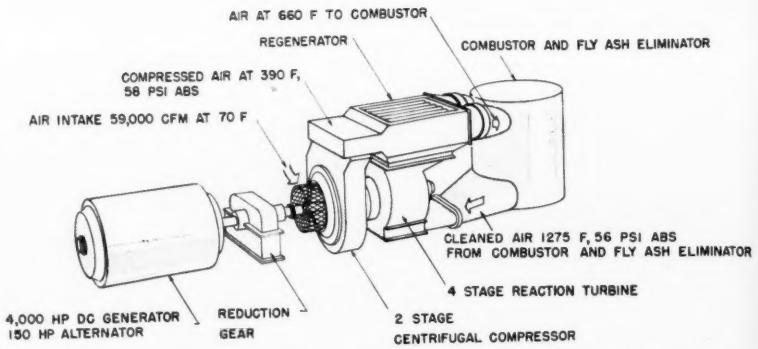
As a rough approximation, the compressor requires about two-thirds of the turbine output, so the plant air rate is about three times as great as the turbine air rate.

Construction Details of Gas Turbines

The general construction of a number of gas turbines has been shown in illustrations in previous sections of this series. The Whittle-type turbo-jet unit is characterized by a simple arrangement in which the single small shaft carries a double-inlet centrifugal compressor on one end and a single-stage turbine on the other. Sleeve bearings are used with forced lubrication. Cooling means are usually provided to deliver air to vital points, thus keeping their temperatures to reasonable values. The General Electric I-40 gas turbine, shown in Fig. 8, is a typical aircraft power plant.

The axial compressor turbo-jet unit, such as the Westinghouse "Yankee" and the General Electric TG-180, is smaller in diameter than the centrifugal compressor type, and its fuel consumption is usually lower due to the higher compressor efficiency.

The power plant turbines that are now beginning to be produced show the influence of the tremendous aircraft development which so greatly accelerated the progress of the gas turbine. Typical of these is the Westinghouse 2000-hp unit shown in Fig. 9. Eight stages of reaction blading are mounted on a single drum, with bearings at each end of the rotor. The compressor which was shown as Fig. 3 in Part III of this series (April, 1947 issue, page 104) is coupled directly to this turbine by means of a rather long shaft, around which the individual combustion chambers are mounted.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COMPRESSED AIR AT 390 F, 58 PSI ABS
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CLEANED AIR 1275 F, 56 PSI ABS FROM COMBUSTOR AND FLY ASH ELIMINATOR
4 STAGE REACTION TURBINE
4,000 HP DC GENERATOR 150 HP ALTERNATOR
REDUCTION GEAR
2 STAGE CENTRIFUGAL COMPRESSOR

Fig. 11. Gas turbine power plant now under construction by Elliott Co. for Locomotive Development Committee, Bituminous Coal Research, Inc.

Provisions for Utilizing High Turbine Inlet Temperature

The highest air temperature which has yet been used in any other than an aircraft turbine is the 1500 F which is employed with the experimental Allis-Chalmers turbine shown in Fig. 10. This turbine utilizes a number of ingenious devices to allow such high temperature air to be admitted to the turbine without causing damage to the materials.

Internal insulation is installed in the inlet duct, which is lined with a high-temperature chrome-nickel alloy. The turbine rotor with its two impulse stages and three reaction stages is overhung, to eliminate both the necessity for a bearing on the high-pressure, high-temperature end of the unit and to allow effective cooling of the first turbine disc. Cooling air is admitted through a hollow shaft and blown against the end of the rotor. This air is recirculated through a second concen-

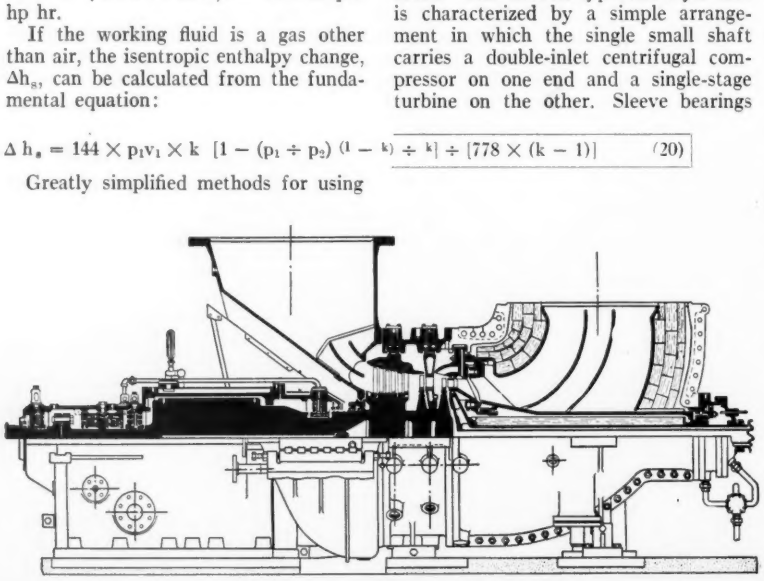

Fig. 10. Cross-section of the 1500-F Allis-Chalmers turbine installed in the Naval Engineering Experiment Station at Annapolis

[2] ("Turbines for Power from Industrial-Process Gases," *Transactions ASME*, May, 1942, p. 287).

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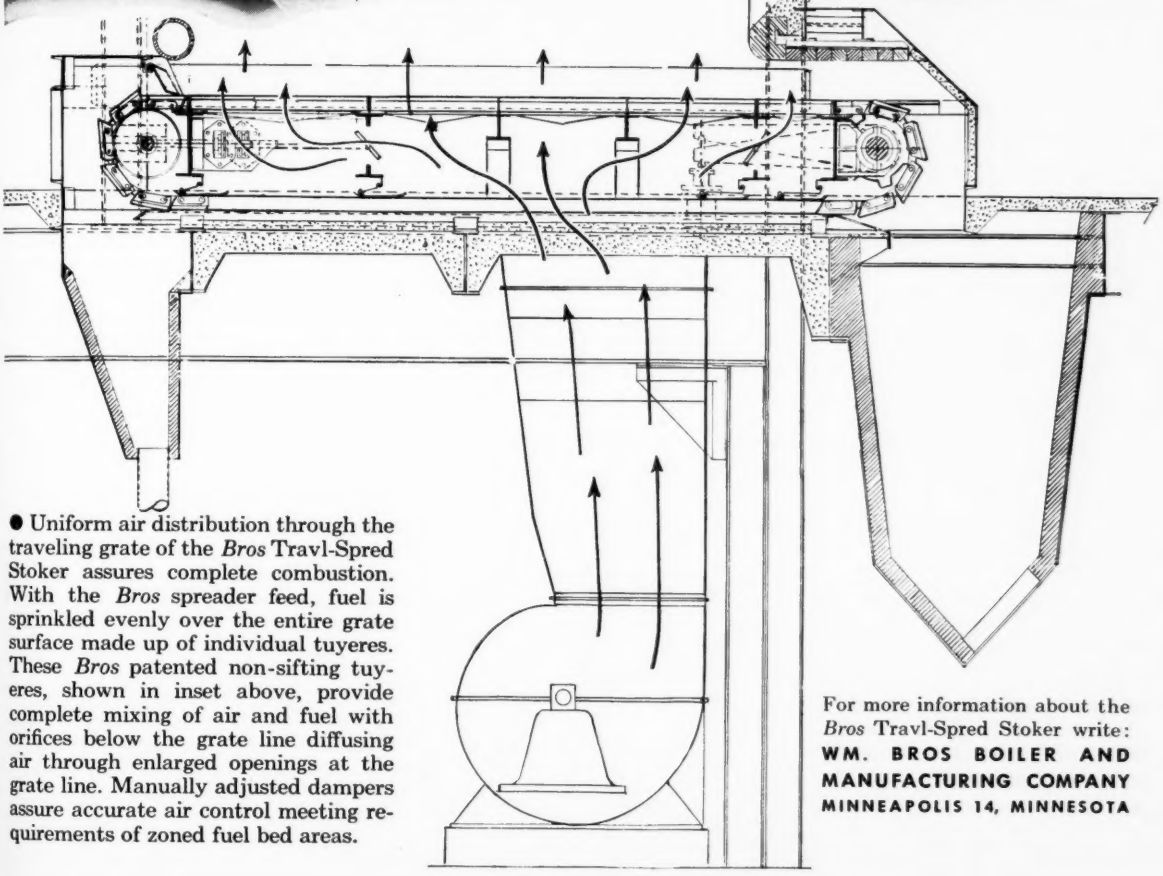

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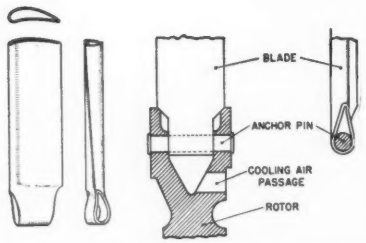

Fig. 12. Air-cooled blade used in the Heinkle-Hirth aircraft gas turbine

tric hollow shaft, and, after passing through a heat exchanger, it returns to the blower, which delivers it under pressure to the turbine. The second stage has hollow nozzle partitions, which allow more cooling air to be blown against the other face of the first disk. The two impulse stages reduce the temperature of the air to the point where no cooling is required by the last three reaction stages. This turbine [3] is installed at the Naval Engineering Experiment Station at Annapolis, Maryland, and it has successfully passed its qualifying test at 1500 F.

The Elliott Co. of Jeannette, Penna., has designed and is constructing for the Locomotive Development Committee of Bituminous Coal Research, Inc., a gas turbine plant which uses a two-stage centrifugal compressor, directly attached to a four-stage reaction turbine. This plant, shown in Fig. 11, uses one bearing between the two compressor stages, and a second bearing at the low-pressure end of the turbine. Since there is no high pressure bearing, there is also no opening to the atmosphere at the high-pressure end of the turbine or the compressor. Gland leakage is thus held to a minimum, for the pressure differential between the compressor outlet and the turbine inlet is small. All the air that leaks from the compressor goes into the turbine, thus helping to cool the shaft and the face of the first rotor disk.

[3] See POWER PLANT ENGINEERING, May 1946, page 86.

How Turbine Parts Are Cooled

The benefits to be derived from high turbine inlet temperature have caused designers to exercise great ingenuity in devising ways to cool the highly-stressed turbine parts. The effect of high temperature is primarily to weaken the blade and disk material to the point where the life of these elements is reduced to an uneconomical minimum. Ordinary carbon steel becomes almost useless at temperatures above 1000 F, because it scales very rapidly and retains little strength. Prior to World War II, there were few alloys which retained their strength above 1100 to 1200 F. Hence, in order to obtain a reasonable plant efficiency, methods had to be devised by which the working fluid could be as hot as possible, while the highly stressed rotating elements were relatively cool.

The obvious thermodynamic method is to use an impulse stage at the turbine inlet, with the highest possible temperature drop in the fixed nozzles. This method is used in the aircraft units, but it is subject to the disadvantage that the stage efficiency is relatively low. The leaving loss is quite high, although in a jet unit this fact is used to aid in the creation of the jet itself.

The use of hollow blades is another obvious device, and it was used by the German jet units in World War II. Figure 12 shows one method which was employed to fasten the blades to the rotor, and still permit the admission of air. Hollow shafts and hollow discs have been used, with innumerable variations of the fundamental idea. The German jet engine designers, having no high temperature alloys at their disposal, evolved many ingenious cooling schemes, descriptions of which can be found in various aircraft publications.

(To be continued)

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American Industrial Progress

IN A comprehensive new survey of America's Needs and Resources, the Twentieth Century Fund indicates that if we continue our past rate of growth into the next decade we can provide our people with still more goods and services than at the wartime peak, with less hours of work. Dr. J. Frederic Dewhurst, Economist of the Fund, directed a staff of twenty experts in a three-year study and did the principal part of writing and editing the final report.

Some outstanding findings and conclusions of America's Needs and Resources may be summarized:

1. America's sensational achievements of the past are measured by figures which show that the net output of our economy was 27 times larger in 1944 than in 1850, turned out by a labor force only 9 times greater and working only 43 hours a week intsead of 70. Our total national income (or net output of all goods and services) produced in 1944 was $161 billion as against $6 billion for 1850 in terms of 1944 prices.

2. This enormous increase in output raised the income of the American people—averaging men, women and children—from around $270 per person in 1850 to about $1,170 in 1944.

3. Gross national product, or the total of all goods and services produced in this country, can well reach $177 billion in 1950 and $202 billion in 1960, if we operate our economic system at levels as high as we attained during the last half of the 1920's. The 1960 figure is higher than our wartime peak output of $200 billion in 1944, and indicates that we are easily capable of a national output in 1960 that is nearly three-fifths higher than our last prewar year, 1940; and 88 per cent higher than our "boom" year of 1929. All figures are in terms of 1944 prices.

4. Jobs would show a total of 57 million in 1950 and 60.2 million in 1960. These estimates allow for about three million unemployed in each year and they compare with our total employment of about 47 million in 1940.

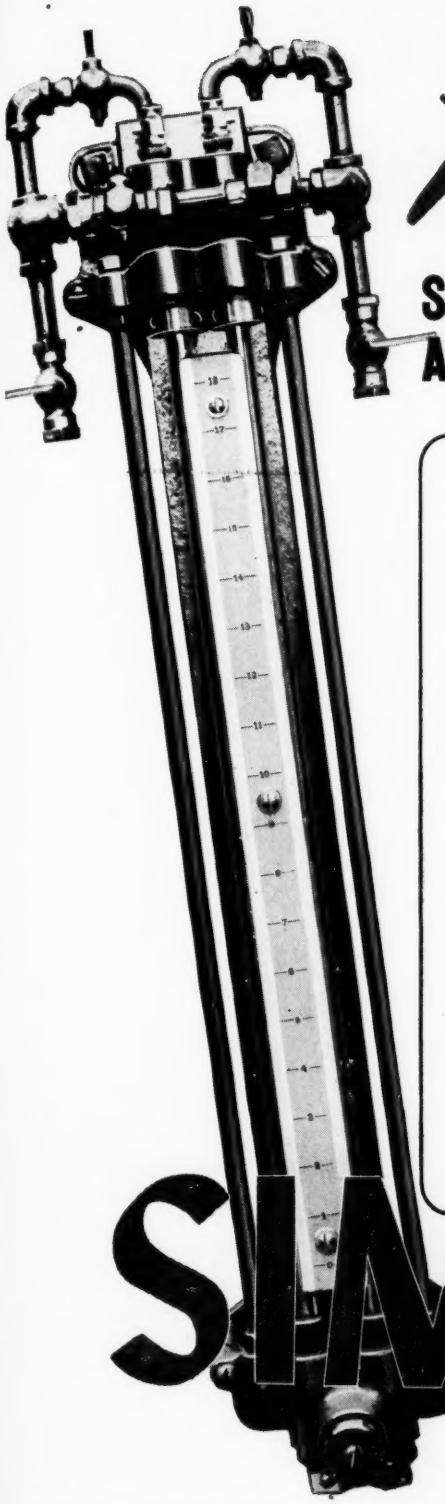
5. The average work week probably will go down to 41 hours in 1950 and 38 hr in 1960, as compared with an average work week of 43 hr in 1940 and over 47 hr in 1930.

6. Output per man-hour of work, due largely to the tremendous amounts of machinery and mechanical power with which America backs up its workers, may well increase by 18 per cent or more during the decade of 1950 to 1960. This figure represents the average increase of all the decades between 1850 and 1940. Today, when an American works one hour he produces more than a worker anywhere else on earth or at any other time in history.

7. All these estimates show probable demand and indicate what our future activity may be if based on actual performance in the past. If estimates are based on "needs," figured as how much more output would be needed to supply every living American with minimum standards of health and decency in food, clothing, housing, medical care, education and other goods and services, gross national product would be 13 per cent greater than the 1950 estimates, and 8 per cent greater than the 1960 estimates.

8. Possibilities for more jobs and still higher business prosperity in the decade are indicated by the margin of still-unsatisfied minimum needs, so that if those needs—and those markets—are met, gross national product would go from the estimated $177 billion to $200 billion in 1950 and from $202 to $219 billion in 1960.

9. Far from being "mature" or "dead," the American economic system is a dynamic growing thing. It holds possibilities for capital expenditures: for starting new businesses, for producing such capital goods as new factories, stores, new school buildings, new hospitals, highways, railroads and transportation systems, etc., etc., probably beyond our capacity, so that a vast area for still greater expansion lies in the future.



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Causes of Instability in D-C Motors

Causes of instability . . . Conditions of operation of different types of d-c motors under which instability can be expected . . . Effects of different kinds of loads . . . Characteristics of series and compound wound motors . . . Limitations of the relations between speed and torque of d-c motors . . . Application of Motor Control

By J. A. JACKSON

Materials Handling and Testing Equipment Division, General Electric Company, Schenectady, N.Y.

A MOTOR is stable when the relationship between torque and speed follows approximately a straight line with a descending slope determined by the IR drop in the motor. This is shown in Fig. 1. It trends toward instability when the speed starts rising as the torque increases, and the ultimate instability is reached when the torque reaches a maximum and the speed stops rising and rapidly falls to a stall.

The most dangerous conditions occur when the motor is being driven by an overhauling load; that is, when it is operating as a generator, for under this load condition it runs away when maximum torque is reached instead of stalling. This condition is shown in Fig. 2.

What causes instability? Torque is proportional to armature amperes times field flux, and armature current creates a flux which opposes the flux produced by the field current. Thus it is clear that to produce a constant torque, such, for example, as is required to drive a horizontal conveyor, both field-flux and armature-current constant must be maintained; or, if either one varies up or down, the other must also vary proportionately in the opposite direction so that the product remains constant. If, therefore, the field is weakened to increase speed, armature current must increase to maintain constant torque. Increased armature current increases the demagnetizing cross flux which further weakens the field flux, demanding a still higher armature current. Thus, the vicious spiral is started and a condition may be reached in which the armature flux takes command and neutralizes all field flux. This gives maximum instability.

Keeping these facts in mind, let us examine some different types of d-c motors and see under what conditions of operation or control instability can be expected. A single-speed general-purpose shunt motor is so designed that the torque at which instability occurs is so far beyond its rated torque that there is little or no chance of its being applied where the breakdown torque will be reached. If, however, advantage is taken of the two-to-one speed range by shunt-field control, for which most shunt motors are guaranteed, chances for instability are increased because the field flux is down to one-half at the high speed. The cross flux from the armature current, however, is approximately the same as at slow speed, assuming the horsepower output is constant. Thus, the percentage of demagnetizing effect is much increased which trends toward instability.

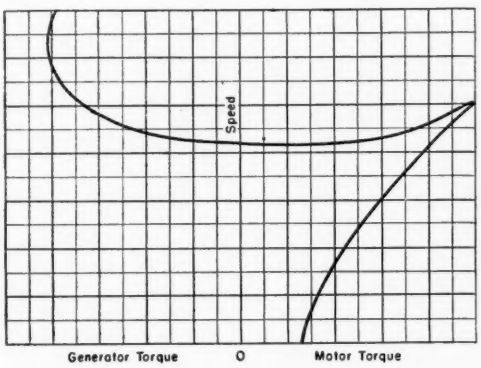

Fig. 2. Unstable speed torque curve of a weak field motor

By the same line of reasoning, it can be readily seen that adjustable-speed shunt motors with 3-to-1, 4-to-1, and 6-to-1 speed range by shunt-field weakening are even more susceptible to instability if any attempt is made to load them beyond the basic speed horsepower rating.

At this point, it might be well to explain briefly the difference between constant torque and constant horsepower applications, since instability is more likely to occur on a constant-torque application if the motor field is weakened.

Going back to fundamentals, horsepower is proportional to torque times speed (rpm) and torque is proportional to armature current times field flux. Thus, for a motor to deliver constant horsepower over a speed range, the torque must go down at the same rate that speed goes up. Since constant horsepower output requires substantially constant input from the line (neglecting small changes in efficiency), this requires constant armature current. To obtain a decreasing torque from constant armature current must require a decreasing flux which is just what happens when the field is weakened to increase the speed. Therefore, an adjustable-speed shunt motor is inherently a constant-horsepower motor. An application which is inherently constant horsepower is a machine tool where the motor output must be dissipated as heat at the cutting edge of the tool. Each size and shape of tool can dissipate a definite amount of horsepower without damage by loss of hardness. Consequently heavy cuts must use slow speed and light cuts can be made at higher speeds, since horsepower is proportionate to area of cut times speed of cutting. An adjustable-speed shunt motor is, therefore, ideal for this application.

By the same line of reasoning, if a constant-torque load, like a hoist, is driven by an adjustable-speed motor, the constant torque can be obtained only by increased armature current each time the speed is increased by field weakening. Thus, at four times speed,

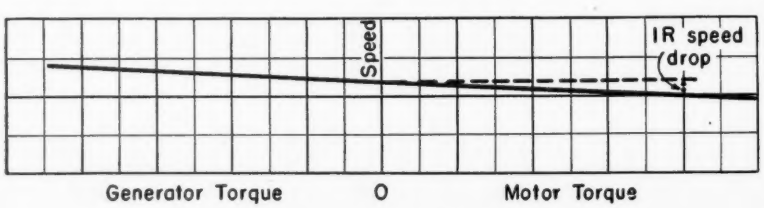

Fig. 1. Speed torque curve of a stable motor

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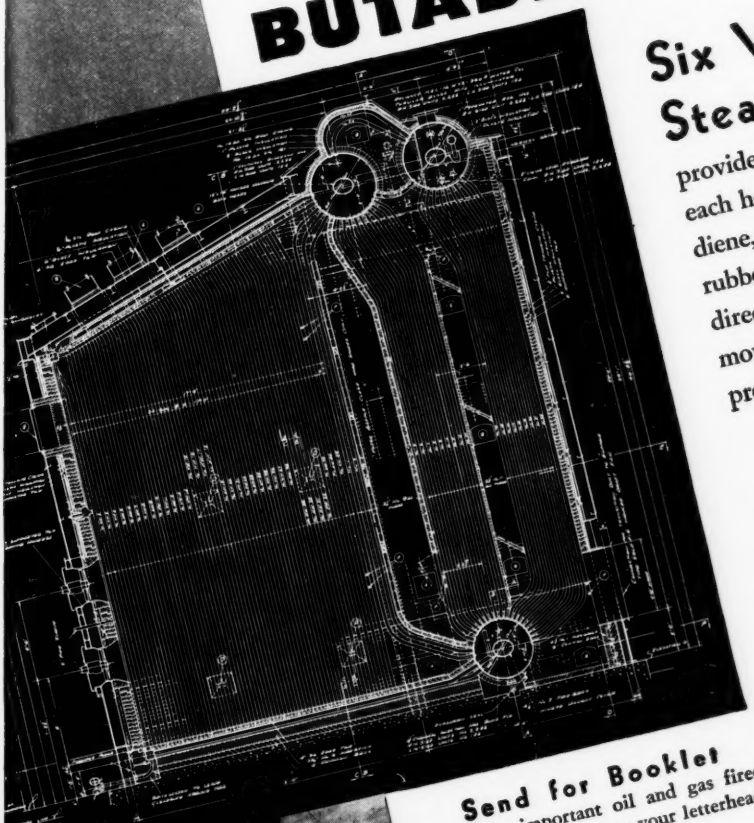

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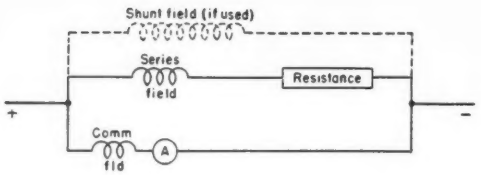


Fig. 3. Control circuit used on last point lowering on a crane hoist. Used with either series or compound wound motors

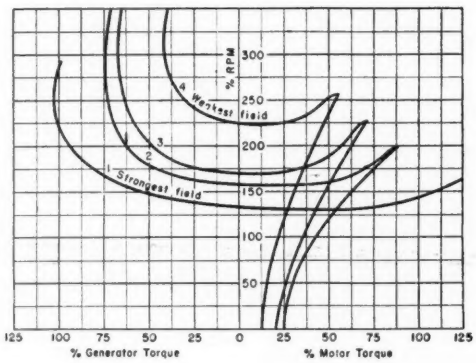


Fig. 4. Approximate speed torque curves of a mill type series motor operating on the 5th point lower with four different adjustments of field resistance to show effect on stability

armature current, input from line, and horsepower output must be up four times and torque has remained constant. The armature current causes sixteen times the heating (I^2R), and its cross flux may so decrease the net effective field flux that the required torque can not be obtained and the motor will stall; Or, if the load is overhauling (lowering) and maximum torque is below load torque requirements, a runaway will occur.

Now let us look at series and compound motors. A series motor, operating as such, is inherently stable because each increase in load increases the field current and flux and thus counteracts the armature current cross flux. Compound-wound motors are stable but to a lesser degree, depending on the ratio of shunt-field ampere turns to series-field ampere turns, those having the largest proportion of series turns being the most stable.

Series motors, however, and, to some extent compound motors as well, are operated from control circuits which provide dynamic braking for holding back overhauling loads, such as occur on winches and hoists. With these connections, the motors operate as shunt or compound generators when the load overhauls. When so operated, these motors, and particularly the series wound, are particularly susceptible to instability. These control connections change the motors from series to shunt wound (see Fig. 3 for control circuit) and the current through the field is reduced by series resistance in order to get high speeds. The series motor thus becomes an adjustable-speed shunt motor operated when lowering as a shunt generator. These are conditions for which it was not designed and instability to some degree is evitable.

Figure 4 shows the approximate speed-torque curves of a series-wound mill motor when operating with control as shown in Fig. 3 and with resistance values to give four different speeds at zero torque. This well illustrates the danger of operating with too weak a field and shows that the weaker the field the lower the maximum possible torque.

From the preceding, it is evident that instability is due more to incorrect motor application than to incorrect control. However, on applications like crane hoists, sufficient field weakening to get instability should not be recommended. Also, when applying control for a shunt motor with field weakening, the application and the motor should be checked to see what speed range is needed and whether the motor will operate successfully and deliver the required torque with the field weakened to get top speed.

The rapid increase in the application of d-c motors to obtain wide speed ratios and to obtain electric braking makes it necessary to understand the limitation of the relations between speed and torque on d-c motors.

GAS COMPRESSOR STATIONS

(Continued from page 72)

called upon to handle a wide range of suction and discharge pressures, there can be no danger of overloading the unit when pressure conditions exist that might damage the working parts of the machine. This is done by unloading the compressor cylinder when it is operating in an unfavorable pressure range. In other words, the output of a compressor or the pressures in the compressor can be controlled by almost any factor in the operation of that compressor that is most important in that particular plant.

Compressor Station Buildings

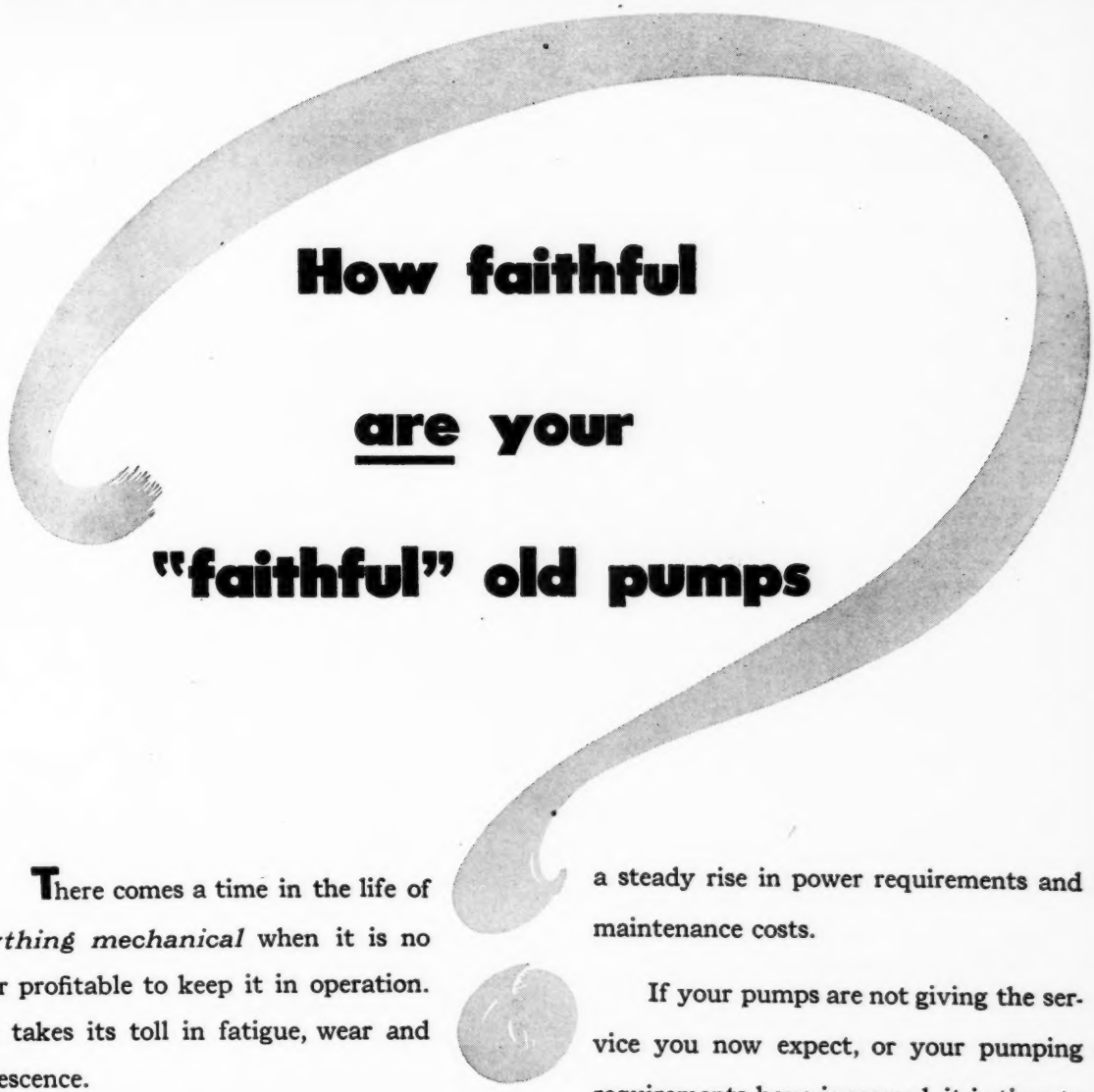
Use of medium-speed engines for driving compressor cylinders has decreased the size of the buildings necessary to house the main units in a compressor station. Taking a 6000 hp main-line station consisting of six 1000-hp V-type engines as an example, we find that the floor space required is 0.7563 sq ft per hp and the cubic content required is 12.634 cu ft per hp. In this arrangement, we have allowed 10 ft between the end engines and the end wall and a 5-ft alleyway around all units.

The same horsepower in slow-speed engines would require 1.737 sq ft per hp and 24.313 cu ft per hp. Then, too, there is quite a saving in concrete in the engine foundations, the medium-speed engine requiring 140 cu yd and the slow speed engine 250 cu yd, a saving of 90 cu yd or 36 per cent.

The standard main line station building generally consists of a steel framework resting on a solid concrete basement wall that is carried up to the main floor level. The basement floor is generally not more than 4 ft below the grade line, which allows the compressor piping to come out of the station above grade. The outside headers are then laid on concrete supports and all outside valves are in plain sight of the station operators. Catwalks are built to each valve for the convenience and safety of the operators. A solid brick wall is carried from the floor to the top of the window sill and corrugated transite is used for the rest of the wall and roof. The windows are steel-sash ventilating type and should be as air tight as possible. Although considered a needless expense by some operators, an overhead crane of some sort is essential in reducing the maintenance cost. This crane should have a capacity of not less than 2 tons.

Heating of a compressor station building can be done by an exhaust-gas furnace or boiler that is supplemented by a gas-or oil-fired boiler for emergencies. In the dust bowl region, some stations are supplied with water-washed air and this has considerable bearing upon the maintenance costs of units in this region. Another innovation is the placing of the motor-driven water pumps for the raw cooling water in a dog house at the cooling tower and having them remote-controlled from the switchboard in the auxiliary house. This decreases the length of the water lines and also decreases the size of the auxiliary building. The auxiliary building is of the same general construction as the main building but does not have a basement. In it are the auxiliary engines direct connected to generators, the air starting compressors, the station office, spare parts and supplies store room, lockers, and wash room.

Each installation will have its own peculiar problems, but if at all feasible, the points outlined should be carefully studied and incorporated in the design of any compressor station.



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P-12

The Comprex—A Pressure Exchanger For Gas Turbines

By **PAUL R. SIDLER,** President, Brown Boveri Corp., New York

DEVELOPMENT of a new type of pressure exchanger known as the Comprex for use on gas turbines has recently been announced. The first full-scale installation of this device has been made on a 4000-hp gas turbine power plant for a locomotive, completed last year in Switzerland and set up for test. The Comprex promises important improvements in gas turbine performance. It is now undergoing test in the shops but it may be several months before the results are available.

One major advance that may be made possible by use of the Comprex is seen when comparing this 4000-hp gas turbine locomotive with the 2200-hp locomotive that has been in daily operation for over two years in Switzerland and France. The 4000-hp unit with almost 80 per cent greater capacity, has almost the same diameter as the older one and is only 3 ft longer.

Another feature is that the Comprex is designed to permit operation of the gas turbine with a temperature at the combustion chamber outlet of about 1800 F but the Comprex itself has to be designed for operation at only 975 F, and, for this value, metals known for years have proved their reliability.

The new pressure exchanger or Comprex is shown in the illustrations. The name Comprex was coined to call attention to the fact that this machine compresses air and expands gas in the same rotor. It was described in detail by this writer before the Midwest Power Conference, Chicago, 1947.

How the Comprex is Built

Figure 1 shows a cross section through this rotor, which consists of a number of cells around the circumference; in our particular case, 30 cells. In a longitudinal view, these cells would not be straight, but are arranged in helical form to obtain better flow characteristics.

The diagram in the upper right corner, Fig. 2, shows the connection of the Comprex in relation to the known elements of a gas turbine plant. Briefly, it forms the higher-pressure stage between the axial compressor of the gas turbine and the combustion chamber.

The diagrams in Fig. 3 show various stages in the operation of the Comprex, but before discussing them, let us trace the flow of air and gas through the gas turbine cycle.

From the outlet of the axial compressor, the air enters the bottom cell in the Comprex and, while its rotor turns one half revolution, the air enclosed in this cell has reached a substantially higher pressure. It is then exhausted—or pushed out—through the circulating fan, which is designed to overcome friction losses between the Comprex and the combustion chamber. Entering the combustion chamber and being heated by burning fuel, the air and gas mixture again reaches the top-cell of the Comprex and while this cell makes one half turn to the bottom, the pressure is reduced by expansion, whereupon the gas enters the reaction section of the gas turbine and expands further down to atmosphere.

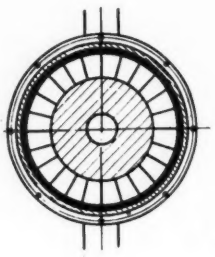

FIG 1

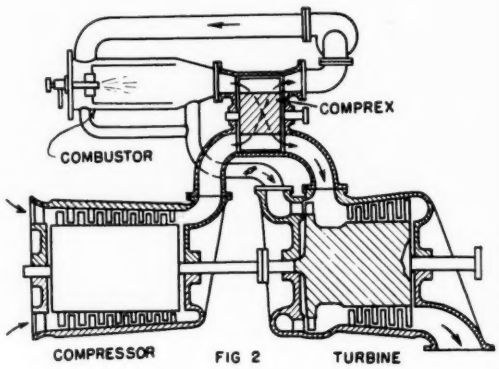

FIG 2

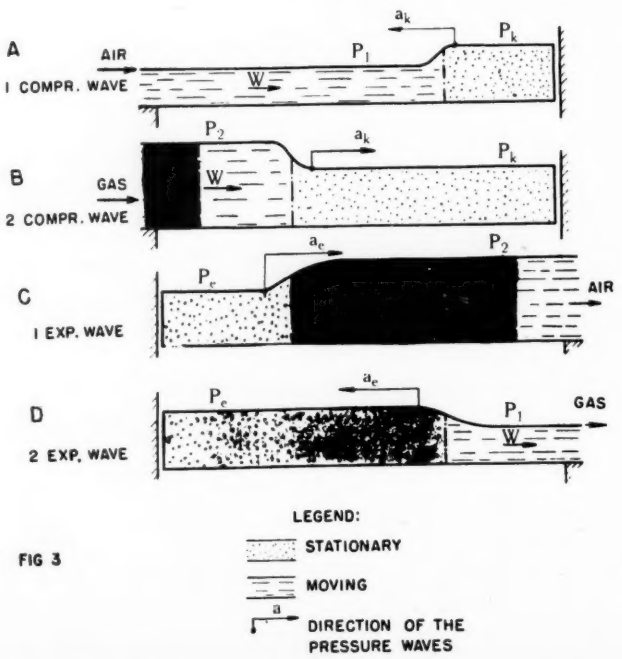

FIG 3

Figs. 1 to 3. Diagrams showing how Comprex is built and used, and principle of operation. Fig. 1. Cross-section through Comprex rotor; cells not straight longitudinally, but in helical form. Fig. 2. How Comprex is installed in relation to gas turbine elements. Fig. 3. Compression and expansion waves in a single cell of Comprex during a single revolution of the rotor

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The cells can only take a fixed volume of air or gas, but since the volume is increased by heating in the combustion chamber, the excess above the capacity of the Comprex is by-passed around it and led to the high-pressure or impulse section of the gas turbine. Since it has a higher temperature than could be withstood by the turbine, this gas is mixed with some cool air which does not participate in the combustion.

It is clear from this summary that any given cell in the Comprex rotor alternately carries relatively cool air and hot gas. Assume that the air enters the cell with a temperature of 400 F and leaves it with 600 F after the compression. On the half turn from bottom to top, the cell therefore is subjected to a mean air temperature of 500 F.

The gas temperature at the exit of the combustion chamber is about 1800 F and through expansion in the Comprex is reduced to say 1100 F. On the second half turn the rotor cell therefore has to stand a mean gas temperature of 1450 F.

Since the two operating phases follow each other very rapidly—with a speed of 6000 rpm, 3000 cells pass any given position each second—the temperature of the rotor is the mean value between the above two averages, or 975 F. Again, due to the rapid succession of compression and expansion, the temperature difference in the rotor during one revolution is below 4 F and this change only penetrates into the metal to the insignificant depth of 0.004 in.

What the Comprex Accomplishes

Consider now the economic importance of this Comprex operation. Although it can take in and work with gas of 1800 F—thereby deriving all the known benefits in efficiency from this high temperature—this rotor only has to be designed with metals able to withstand the average temperature of 975 F., i.e., metals that have been known for many years and have proved their reliability in this temperature range. The Comprex also increases the air pressure in the ratio of 3:1.

In this locomotive unit, the addition of the Comprex results in an increase of the output of 80 per cent—from 2200 to 4000 hp—and an improvement of the efficiency of 25 per cent, from 18 to 22.5 per cent, everything else being equal.

Having thus surveyed what the Comprex does to a gas turbine cycle, I shall now try to explain how this is done.

Compression and Expansion in Comprex Cell

The diagrams in Fig. 3 show one cell of the rotor under four different operating conditions. Taking the top diagram, A, you will observe the air entering from the left. This air is at about 60 psig pressure, coming from the axial compressor. As it reaches the right end of the cell, this end is suddenly closed and a pressure wave is produced, which is reflected by the wall and travels from right to left with the velocity of sound. When the wave reaches the left end, this is also closed and we have now enclosed in the cell a volume of air at a substantially higher pressure than before. This action has a close parallel in the hydraulic field, in the form of the hydraulic ram or water hammer.

Going now to the second diagram, Fig. 3B, we see the left end opened and gas entering from the combustion chamber at higher pressure. While the right end of the cell is still closed, this gas piston forces the air into a smaller space, thereby increasing its pressure. This second pressure wave again travels from left to right. When it has reached the right end, the exit is opened and the gas continues to push the air out.

Meanwhile, as we proceed to the third diagram, C, we note that the left end is closed and as the gas piston continues to move towards the right with undiminished speed, it creates behind it an area of lower pressure. We might thus say that now an expansion wave or "negative pressuge wave" moves from left to right.

Going now to the last phase, at D, Fig. 3, we see that all the air to the right of the gas piston has been pushed out and as the gas can now flow out without the restriction of the air before it, its pressure drops further and a second expansion wave travels from right to left. When it has reached the left end, the cell is again back to the starting pressure level and the cycle begins anew.

During this one cycle, the rotor has completed one revolution and our sample cell is back in the starting position. The cell wheel rotates between two fixed end shields, with suitable openings or ports through which the air and the gas enter and escape. As shown in Fig. 2, the air enters always when the cell is at the bottom and leaves when it has reached the top. In that position also the gas enters but it can only leave when the cell is back in the bottom position.

It is quite clear that to produce these several waves in each revolution, the speed of the cell wheel must be accurately controlled or kept in step. This is one of the problems in the operation of the Comprex which is now being worked out through systematic tests. While no definite date for the completion of this work can as yet be given, the progress made so far, together with the results of the earlier pilot unit, leave room for the expectation that in the relatively near future we shall have taken another significant forward step in the gas turbine field.

SOLAR-HEAT COLLECTOR

THE EFFECTIVE use of the sun's heat for residential heating has been brought closer to realization as a result of wartime research sponsored by the War Production Board's Office of Production Research and Development, according to a report (PB25375) on sale by the Office of Technical Services, Department of Commerce, Washington 25, D.C. The 154-page report describes the construction and operation of two successful solar-heat collectors which were developed at the Engineering Experiment Station of Colorado, Boulder, Colorado.

The heat collector consists of a group of partially blackened, overlapping glass plates, mounted on a house roof. The arrangement is similar to that of shingles, separated by small air spaces. A glass cover over the staggered plates is employed to keep out dirt. By virtue of the high transmissivity of glass for solar radiation, and its low transmissivity for long-wave thermal radiation, the black and clear glass surfaces in the unit become heated when exposed to sunlight, and the reradiated heat has no avenue of escape. Air passing between the plates is heated from the trapped heat of the sun, and forced into the house. Experiments prove that heat can be collected at a higher temperature level by this method than can ordinarily be attained by other types of solar collectors.

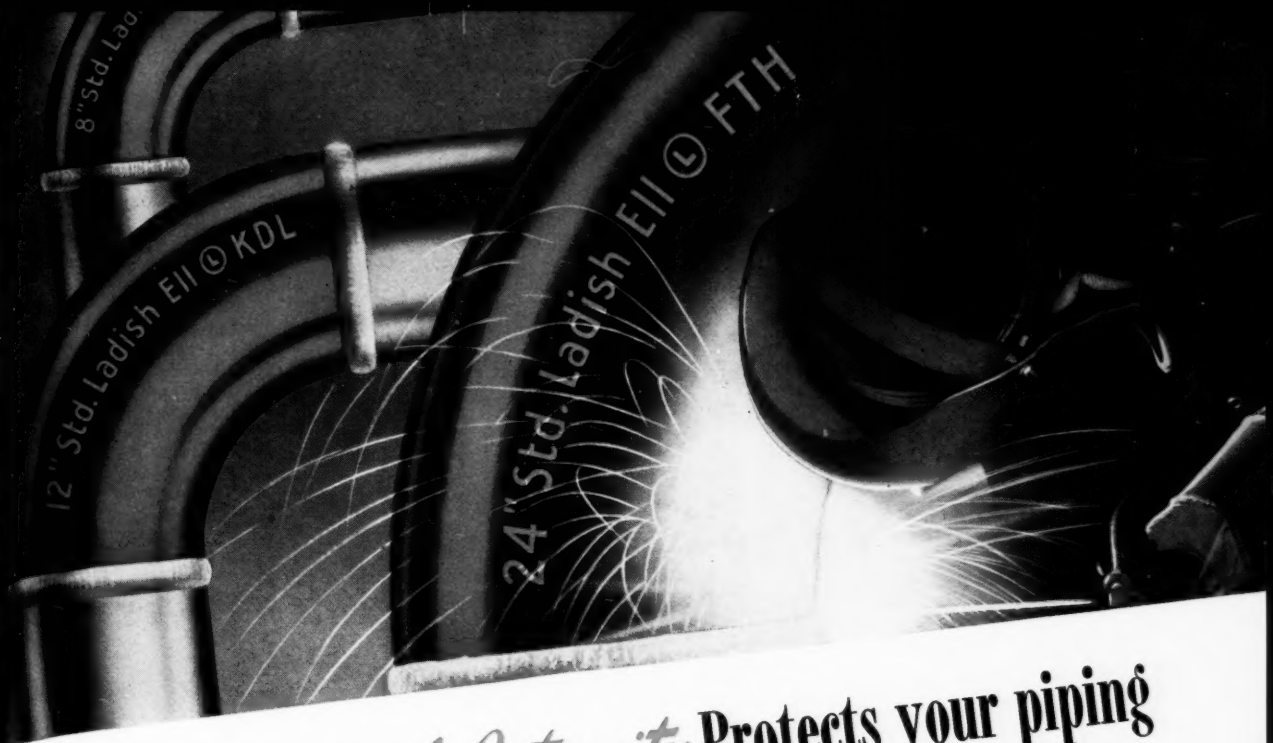
The experimental house installation saved 20 per cent of the fuel that would otherwise have been needed during the test period. It is reported that a more efficient unit currently being designed, could save up to 60 per cent of the fuel requirements, according to a summary of the report in Mechanical Engineering, Feb. 1, 1947.

Results of all tests indicated that solar heat can be recovered with efficiencies as high as 40 per cent, with exit-air temperatures above 150 F. Higher temperatures can be secured, but at lower efficiencies.

For most efficient home operation, it is stated, ducts should be thoroughly insulated, and a method of storing the heat for a maximum economical period of one day should be developed. It is estimated that a storage bed containing about six tons of dry solids would suffice. If the air were recirculated between the collector and the storage unit, the storage bed might be appreciably smaller. Experiments on the storage bed are being conducted by investigators at the University of Colorado.

Locations north of the 40th parallel are generally unfavorable for economical solar house heating, the report states. Because of the possibility of using solar-heated air to operate an absorption type of air conditioner, it is felt that the greatest applicability of this system would be in the South.

This solar-heat collector appears to have an efficiency in the same range as that of the flat-plate collectors in which water is heated, and its operation is more efficient and flexible than the method employing large south windows.



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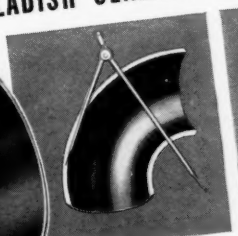

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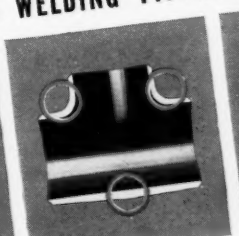

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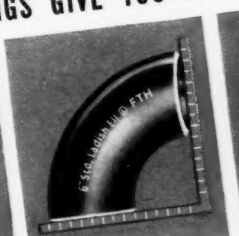

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19TH OIL AND GAS POWER CONFERENCE AT CLEVELAND

FEATURED by technical and general sessions, plant inspection trips and a large exhibit of engines and accessory equipment, the 19th national Oil and Gas Conference of the American Society of Mechanical Engineers was held at the Hotel Statler, Cleveland, Ohio, May 21-24.

A pre-conference series of three lectures on Diesel fuel oils, by recognized authorities, was held for the first time, as a new idea in technical education for practicing engineers. Another feature of the conference was an address on "What is New in Engineering," by E. E. Johnson, manager of the engineering apparatus department of General Electric Co., at the informal banquet Thursday evening May 22, at which Lee Schneitter, Diesel engineer with Ebasco Services, Inc., New York, presided. He is chairman of the Oil and Gas Power Division of the ASME which sponsored the conference. E. J. Schwanhausser, vice president of the Worthington Pump and Machinery Corp., and president of the Diesel Engine Manufacturers Assn., Chicago, was toastmaster.

The first certificates of award ever to be conferred by the oil and gas power division were given to six men for excellence of technical papers given before the society, retroactive to 1943. They were presented to:

Professor F. A. Firestone, the University of Michigan, for a paper on "The Supersonic Reflectoscope for Inspecting Materials." J. K. Salisbury, General Electric Co., Schenectady, for a paper on the basic gas turbine plant; S. A. Tucker, McGraw-Hill Publications, New York, for "Gas Turbines—Present Status and Future Prospects;" M. A. Elliott, U. S. Department of the Interior, Bureau of Mines, for a paper on correction of Diesel power measurement to standard atmospheric conditions; J. I. Yellott, Locomotive Development Committee, Bituminous Coal Research, Baltimore, and E. F. Lype of the Armour Research Foundation, Illinois Institute of Technology, Chicago, for a paper, co-authored, on some effects of pressure loss in gas turbines.

What's New

Discussing reasons why the philosophy of his company insures that there will always be something new in engineering, E. E. Johnson reviewed first the scope of his company's products. At one end of the scale, they are working on a 500,000-hp power plant in one unit (a plant for a guided missile which develops that power for 60 seconds). At the other end of the scale are glass bearings for instruments, so small that several hundred bearings can be placed in a spoon. After discussing new developments in steam turbine generating units, Mr. Johnson reviewed GE gas turbine developments, describing the 4800-hp, 1400-F gas turbine unit now under construction for locomotive use. A 5000-kw gas turbine plant suitable for central station and industrial application is also being designed. Mr. Johnson sees need for standardized design of gas turbine types and sizes and expressed optimism over its possibilities.

Vegetable Oils as Fuels

Comparing various vegetable oils—soy-bean, peanut, cotton-seed and others—as fuels for compression-ignition type engines, A. W. Baker and R. L. Sweigert of Georgia School of Technology concluded they are possible fuels. They would, however, need refining to approximate Diesel oil. Further study would be needed on carbon tip formation and corrosion. Aside from the engineering, however, the economic factors would govern. Since most of the vegetable oils cost about $1 per gallon as against Diesel fuel of about 8 cents per gallon, their use at present could only be in parts of the world where the vegetable oils are available in quantity but petroleum products expensive and scarce.

How fuel injection may bring about significant changes in high-powered, supercharged aircraft piston-engine design, to compete with the turbine-type aircraft plant, was discussed by Dr. Israel Katz of Cornell University. To burn lower octane fuels in high-compression engines, using a modified Otto cycle and turbo-scavenging and fuel injection, much design work needs to be done. Compounding of engines with turbine-type plants shows promise.

Diesel Engine Bearings

Considerable attention was devoted to Diesel engine bearings. Bernard J. Esarey of American Brake Shoe Co., pointed out that bearing test rigs and conditions are so rigid that they approach the ideal but give misleading data for use in actual engines. In real engines conditions are not rigid nor stable, loads vary, bearing surfaces are not as in the diagrams, bolting up the housing may change clearances, crank cases may distort in service.

Babbitt metal, he said, is still the best material within its strength limit, giving composition of three type that will cover the field—tin-base, silver-lead base, and lead-base babbitts. However, for high stresses or heavy pounding, various bronzes must be used. He then analyzed bearing characteristics in terms of fatigue strength, embeddability and conformability, seizure resistance, corrosion resistance and bondability—if a lined bearing. Finally he discussed composite, centrifugally cast and plated bearings.

Large bearings were discussed by E. Crankshaw and G. W. LaPier of The Cleveland Graphite Bronze Co. They pointed out the importance of wall thickness on the final quality of the bearing, stating that the tendency is to keep the walls too heavy. They reported and analyzed tests to show that thinner steel backs give greater uniformity and soundness to the bearing material, greater load carrying capacity, lower cost in fabrication, better assembly and operation.

The Fuel Oil Situation

The Diesel fuel oil situation was analyzed by E. F. Miller and F. L. Nelson of Socony-Vacuum Laboratories. Consumption of petroleum products in the U. S. in 1945 was about 4.75 million barrels daily. In 1950, it is thought we shall be using ⅓ million barrels more than this daily; and by 1960 about 10 per cent more. Increase in demand for products comes from extended use in established fields and development of new fields of application. Decrease of kerosene demand and increase of gasoline demands were plotted, also effects of converting ships from coal to oil. In the Diesel fuel market, total consumption may be 135,000 bbl per day in 1948 as compared to 65,000 bbl per day in 1939. Ships will be large users of this fuel but railroad applications are expected to increase 10-fold between 1939 and 1949.

The Armed Services, utilities and industry are expected to double their consumption of fuel oil in the same period.

Fuel that will be available 5 or 10 years from now will be influenced by changes in refinery processing and types of crude oil available. The speakers concluded that catalytic cracking produces a fuel oil of better quality than thermal cracking. They also stated that the future Diesel fuel supply will be lower in cetane number and higher in sulfur content. But these problems will be solved either by modified engine designs and improved lubricants or by balancing premium cost of low sulfur fuels against maintenance costs.

Other technical papers were: "Suggestions on the Use of Combustion Engines in Locomotives" by Prof. G. E. Unger, National School of Engineering, Lima, Peru. "Test Results of Internally Cooled Supercharging" by R. H. Miller, chief engineer, four-cycle engine division, Nordberg Manufacturing Co., Milwaukee. "Is Fuel a Major Factor in the Smokeless Operation of a Locomotive or Stationary Diesel?" by R. J. Bender, assistant to chief consulting engineer, Sinclair Refining Co., New York. (Further data on this will be given in a future issue.) "Sleeve Bearing Design Fundamentals for Diesel Applications" by W. E. Thill, design engineer, Federal-Mogul Corp., Detroit, "Behaviorism of Aluminum Alloy Bearings in Diesel Engines," by D. B. Wood, development engineer, Cleveland division, Aluminum Co. of America.

Cleveland Plants Visited

Among the Cleveland plants visited by the engineers were: Cleveland Diesel Engine Division of General Motors; laboratory of the National Advisory Committee for Aeronautics; Cleveland Graphite Bronze Co.; Alcoa research and development laboratories; and Ohio Crankshaft, Inc. Chairman of the Cleveland Section, hosts at the conference, is E. B. Crankshaw of the Cleveland Graphite Bronze Co. A committee of 30 engineers from the Cleveland group, headed by P. B. Jackson, was in charge of arrangements.

This unit is designed for maximum output in a limited space. It is a combination of a simple two-drum boiler bank, having perfect U-tube circulation, and a water-cooled furnace, integral with the boiler. The large amount of surface exposed to radiant heat results in a quick-steaming unit that will give rapid response to load changes. This unit is adaptable to all fuels and is available in all sizes.

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New ENGINEERING BOOKS

The Hiwassee Project, Technical Report No. 5, Volume 1, by the Tennessee Valley Authority; 367 pages, 116 illustrations; 6 by 9 inches, cloth binding; procurable from Superintendent of Documents, Washington, D. C. Price $1.25.

This is the first of two volumes to be published covering five projects constructed by TVA in the Hiwassee Valley. These projects are: Hiwassee, Apalachia, Ocoee No. 3, Nottely, and Chatuge.

Volume 1 describes the Hiwassee project on the Hiwassee River in Western North Carolina, and how it fits into the program for unified development of the Tennessee River system. It covers preliminary investigations for the project, including geology, river flow, and social and economic studies; dam and power house design; access routes to the dam site; construction methods, including construction plant and river diversion; relocation and adjustments made necessary by creation of the reservoir; initial operations; complete summary of the project costs.

The appendixes include a complete statistical summary of the physical features of the project; reports of engineering and geologic consultants; summaries of special studies, such as hydraulic model studies, cement selection, and aggregate investigations; and the experimental testing program carried on during construction and for several years thereafter to determine the structural behavior of the dam. Bibliographies on each phase of the project are also included.

Publication of this book, originally scheduled for 1942, was postponed pending completion of the other four TVA projects in the Hiwassee Valley, then further delayed because of the war. Other published reports in this series include: The Norris Project, published in 1939; The Wheeler Project, 1940; The Pickwick Landing Project, 1941; The Guntersville Project, 1941; and The Chickamauga Project, 1942. As long as the supply exists, the Norris and Pickwick Landing reports may be procurred from the Superintendent of Documents, Washington, D. C., and the Guntersville and Chickamauga reports from the TVA Treasurer's Office, Knoxville, Tenn.

Fluorescent Lighting, by A. D. S. Atkinson; First Edition; 144 pages; 5½ by 8½ inches; illustrated; cloth; published by the Chemical Publishing Co., Inc., 26 Court Street, Brooklyn, N. Y.; 1946; price $3.50.

During the past few years fluorescent lighting has reached a high stage of perfection. The first fluorescent lamp was a natural development from the electric discharge lamp. Although highly efficient in converting electrical energy into light energy, the electric discharge lamp gave a spectrum very far removed from that of natural light. To improve this, the discharge tube was enclosed in an outer bulb, the inner surfaces of which was coated with fluorescent powder.

It is hardly necessary to call attention to the importance of modern fluorescent lighting, not only in industry but also in offices, schools and homes. This authoritative and interesting book has been written as a reference work which includes the latest available information and data on fluorescent lamp practice. Full details of the construction and operation of all types of fluorescent lighting are given and the application of fluorescent lamps in factories, public buildings, domestic interiors, etc. is discussed and illustrated.

Many difficult lighting problems have been solved by the aid of fluorescent lighting and the future certainly has in store further expansion and many new fields of this type of illumination. This book will be found invaluable by illuminating engineers, consultants, architects, contractors and other technical workers in the electrical field. This book is a facsimile of the British Second Edition. The terms used in the book are British and not in accordance with the American terminology used in the field of fluorescent lighting. For instance in this country fittings are called reflectors or luminaries, plug points are called convenience outlets, etc. Nevertheless, this difference in terminology should in no way detract from the value of this book to American readers, as it contains much interesting and valuable information. It is written in an authoritative manner and in an enjoyable, clear and simple style. American engineers and technical workers should not encounter any difficulties because of the slight differences between British and American practice.

Electronic Theory of Acids and Bases, by W. F. Luder and Saverio Zuffanti; First Edition; 165 pages; 6 by 8½ inches; illustrated; cloth; published by John Wiley & Sons, Inc., New York; 1946; price $3.00.

This book presents in elementary fashion the various aspects of one of the most important existing chemical theories—the electronic theory of acids and bases. This theory is due to the brilliant intuition of G. N. Lewis by whom it was first proposed in 1923. Unfortunately it was largely overlooked until about 1940. Since then numerous papers have been published supporting and developing the theory which is becoming known as the Electronic Theory of Acids and Bases.

According to the Lewis theory, acidity and basicity had nothing to do with the presence of any one element or specific group of elements nor is any particular substance to be considered an acid or a base in an absolute sense. Acidity and basicity are relative terms indicating certain types of experimental behavior which may be exhibited by the vast majority of chemical compounds. Most of them may behave either as acids or bases depending upon conditions.

This theory makes possible a great increase in the amount of correlation possible in all phases of chemistry. It casts a flood of illumination over a wide range of apparently unrelated phenomena, from the corrosion of metals to catalysis in organic chemistry.

This book attempts a systematic presentation of the relationship of the electronic theory of acids and bases to chemistry as a whole. Much of the material has been published previously in a series of papers in the Journal of the American Chemical Society, the Journal of Chemical Education and Chemical Reviews. These papers aroused so much interest that the author was encouraged to recognize and combine them with some new material in this book. The Electronic

(*Continued on page 190*)

NEWS *from* THE FIELD

FUEL ECONOMY CONFERENCE AT THE HAGUE

THE WORLD Power Conference has announced an international Fuel Economy Conference to be held September 2 to 9, 1947, at The Hague, Netherlands. Subjects for discussion will be the production, distribution, and utilization of fuels of all types, with special reference to war-time experiences and to developments realized since 1939 or now in prospect. Details of the program will be available later this summer. It will include an inspection trip at the Netherlands State Coal Mines in the Province of Limburg, together with the associated electric and gas works.

The Netherlands National Committee, at whose invitation the Conference is being arranged, includes Dr. Ir. J. A. Ringers as Honorary President, Ir. G. J. Th. Bakker as Chairman, and Prof. Ir. J. C. van Stavaren as Second Secretary The program is being arranged in cooperation with the national committees of the 32 other member countries.

Applications for membership in the Conference may be addressed to: H. C. Forbes, Treasurer and Secretary, Executive Committee of U. S. National Committee, 4 Irving Place, New York 3, N.Y.

STEAM EQUIPMENT FILM

YARNALL-WARING Co., Mermaid Lane, Philadelphia 18, Pa., has announced the release of a 30 minute color and sound movie, titled "An Engineering Reason." Modern steam and mechanical engineering research which has been responsible for revolutionary improvements in steam plant auxiliaries is described in the production. Lowell Thomas is the commentator in the film and his vivid word pictures make the film clear and interesting to engineer and layman alike.

Bookings of the film are now being made and all requests, when made on company letterheads, will be honored with a free showing of the picture.

BCR STARTS AIR JET CLINICS

WITH AN increasingly large number of coal company fuel engineers faced with design problems as the demand builds up for modern overfire air jets in smoke abatement work, the coal industry's research agency, Bituminous Coal Research, Inc., has begun a series of "Jet Clinics" to provide up-to-the-minute information on installations for all types of commercial and industrial plants.

The first meeting, held here in Chicago at the Hotel Morrison, was conducted by William S. Major of Pittsburgh, Pa., BCR development engineer. He was assisted by Howard Herder, fuel engineer, Sahara Coal Co., and R. L. Sutherland, combustion engineer, Truax-Traer Coal Co., both of Chicago. More than 30 engineers attended the clinic, heard a lecture by Mr. Major on "Modern Overfire Air Jets and Smoke Abatement" and then solved jet problems, using special work sheets provided for the purpose.

Three typical problems were available. The engineers made use of Technical Report No. VII, Application of "Overfire Jets to Prevent Smoke in Stationary Plants," published by BCR, as well as additional information furnished by Mr. Major. Discussion followed both the lecture and the work period.

Those in attendance suggested that another clinic be held in Chicago within six months. It is expected that similar meetings will be requested by engineers in other coal marketing centers of the United States.

COMMONWEALTH EDISON'S POWER PROGRAM

ELECTRIC POWER use in the Chicago area is now 50 per cent higher than before the war and in order to meet this growing demand, Commonwealth Edison Co. is adding to its previously announced program for new generating capacity. Orders were placed recently, the announcement said, for an additional 107,000 kw generating unit to be installed at the Joliet station of its subsidiary, Public Service Co. of Northern Illinois. Another 150,000 kw addition is under study, the location of which has not been decided.

These projects are in addition to those previously announced which include a 107,000 kw unit for the Calumet station which will be ready for use this summer and a 150,000 kw unit at Fisk station which will be completed early in 1949. The company also expects to be relieved soon of the necessity of furnishing power to other companies which will give it an additional 50,000 kw of capacity.

Present generating capacity of the Edison system is 2,303,000 kw. This winter's peak load was 2,250,000 kw reached last Dec. 18. This peak load was 211,000 kw higher than that of the preceding winter. The system's reserve capacity has diminished steadily in recent years as the load increased and the company was prevented by war restrictions from making its normal additions. Power sales last year were 52 per cent larger than in 1939.

HILLIS RECEIVES CHANUTE MEDAL

GEORGE C. HILLIS, general inspector, Western Union Telegraph Co., was chosen to receive the Octave Chanute Medal for the year of 1946 from the Western Society of Engineers, Titus G. LeClair, President of the Society announced.

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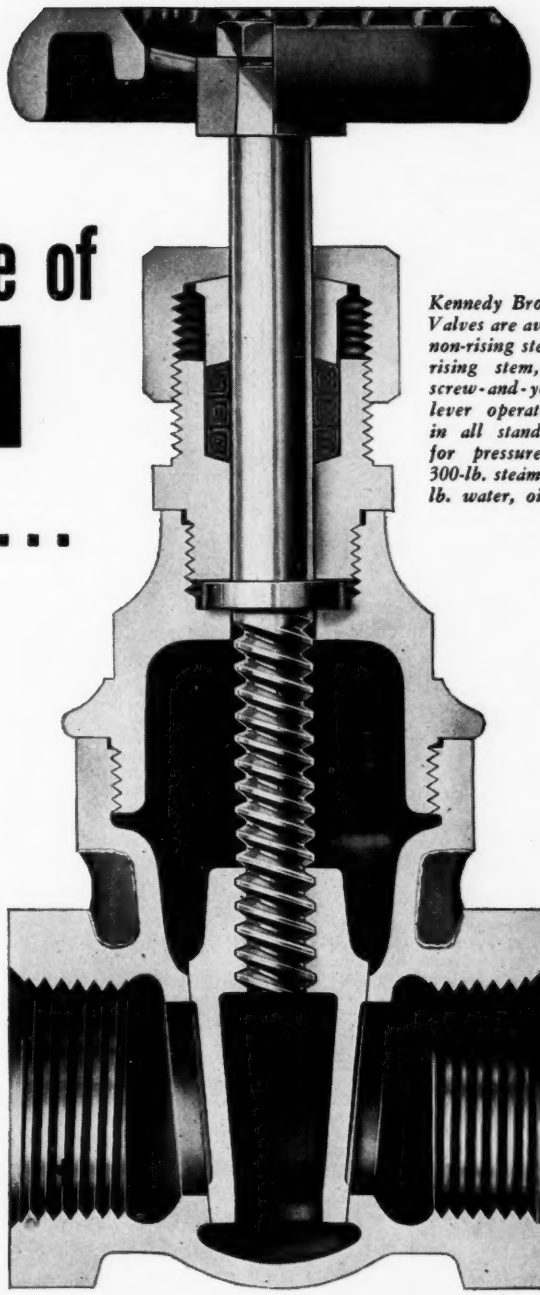

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The Chanute Medal is awarded each year for best papers on various engineering subjects presented before the Western Society of Engineers. Mr. Hillis' prize winning paper was "Telegraphy—Pony Express to Beam Radio."

KAHLER HEADS WESTERN SOCIETY

WILLIAM V. KAHLER, vice president, Illinois Bell Telephone Co., has been elected President of the Western Society of Engineers for the year 1947-48. Verne O. McClurg, consulting engineer, firm of Mundie-Jensen-McClurg, becomes first vice-president. Gustav Egloff, director petroleum technology, Universal Oil Products Co., becomes second vice-president and M. W. Casad, plant extension engineer, Illinois Bell Telephone Co., was re-elected treasurer, Leigh S. Keith and Bolton G. Anderson remain as secretary and assistant secretary respectively.

Titus G. LeClair, chief staff engineer, Commonwealth Edison Co., is the retiring president. New members of the Society's board of direction are—Charles E. DeLeuw, president DeLeuw, Cather & Co., and Eldon A. Imhoff, electrical engineer, Chicago Rapid Transit Co.

JENNISON'S CAPACITY TO BE DOUBLED

PLANS FOR an expansion program that will double the production capacity of the New York State Electric & Gas Corp.'s 45,000-hp Jennison generating station at Bainbridge were announced recently.

With engineering plans under way, the expansion is being undertaken to replace in part power now purchased by the company and to meet the increasing demands for electricity throughout the territory served by the company.

The Jennison station addition is a part of the company's long range program which includes construction of a 45,000-hp steam generating station at East Corning, now under way, and the planned expansion program that will double the production capacity of the Greenidge station at Dresden to 120,000-hp.

The building program at Bainbridge calls for the construction of a large addition to the station in accord with plans made when the station was erected. The addition will conform with the station's brick and steel construction.

Installation of the new turbo-generator with a maximum capacity of 45,000-hp will supplement the plant's 45,000-hp unit and increase its total generating capacity to 90,000-hp.

The installation will include the necessary boiler equipment, additional substation facilities, high voltage transmission lines and other auxiliary equipment.

The order for the turbo-generator has been placed with the General Electric Co., with delivery scheduled for 1950. The construction program will be started in the spring of 1949 and it is expected the new unit will be placed in operation during 1950.

ASA OFFICERS

FRANK T. WARD, vice-president and chief engineer of the Third Avenue Transit Corp., New York, N.Y., has been elected chairman and Frank O. Hoagland, vice president of Pratt and Whitney Division, Niles-Bement-Pond Co., Hartford, Conn., has been elected vice chairman of the Mechanical Standards Committee of the American Standards Association, P. G. Agnew, vice president of ASA, announced recently.

Mr. Ward represents the American Transit Association; and Mr. Hoagland the National Machine Tool Builders' Association on the Committee.

FERGUSON BUILDING HUGE PLANT

A PLANT with an output great enough to supply finishing lime for 200 new veterans' houses daily is now under construction for The Kelley Island Lime and Transport Co. at White Rock, O., according to an announcement by the H. K. Ferguson Co., industrial engineers and builders.

The new installation consists of a completely new plant to process kiled lime, a product used for plastering walls.

The Ferguson Co. is also engaged in modernizing existing quarry facilities of The Kelley Island Lime and Transport Co. at Gibsonburg, O. When completed, the quarry will deliver 2000 tons of limeston daily.

Cost of the families, which are being designed, built and equipped by The Ferguson Co., will be approximately $800,000.

SAFETY STANDARDS CATALOG READY

A CATALOG containing a list of approximately 200 standards covering safety and industrial health is now available to safety engineers, legislators and others interested, the American Standards Association, 70 E. 45th St., New York 17, N.Y., has announced.

The twenty-page booklet not only lists the standards, but gives a brief description of their contents to make it easier for those interested to locate standards concerning their own particular field.

FLANNERY HEADS REMA

E. M. FLANNERY, vice-president of the Bush Manufacturing Co., Hartford, Conn., was elected president of the Refrigeration Equipment Manufacturers Association, largest organization of producers of refrigeration and air conditioning parts, chemicals, complete units and complete systems, at the anunal meeting in Chicago.

Mr. Flannery succeeds H. F. Spoehrer, vice-president of the Sporlan Valve Co., St. Louis, who becomes a member of the association advisory board.

Other new officers elected were H. F. Hildreth, sales manager, refrigeration specialties division, Westinghouse Electric Corp., Springfield, Mass., vice-president; R. H. Israel, sales manager, Virginia Smelting Co., West Norfolk, Va., treasurer, and K. B. Thorndyke, vice-president, Detroit Lubricator Co., Chicago, secretary. These three, with Mr. Flannery, comprise the association's executive committee for the coming year.

TECHNICAL REPORTS LISTS AVAILABLE

FOR THE convenience of businessmen and researchers, the Office of Technical Services, Department of Commerce, has prepared selective lists of technical reports and documents available from OTS in 13 specialized industrial fields, it was announced recently.

The lists cover the following fields: plastics; vibrators, tampers, pneumatic tools, and drills; jet engines; psychology; infrared; ceramics; magnetic tape machines (Magnetophone); adhesives; paper; deterioration, guided missilts; iron ores; and forestry and wood products.

Each of the lists cites author, title, price, and reference number of the reports included. For example, the list on deterioration cites about 200 OTS reports. These include reports of studies on tropical deterioration made by various branches of the armed services and the Office of Scientific Research and Development, and various technical documents acquired by OTS investigators in Germany.

The lists contain only the most important materials available from OTS in each of the selected fields. A complete listing of all available documents is contained in OTS' weekly Bibliography of Scientific and Industrial Reports. The weekly bibliography is obtainable from the Superintendent of Documents for $10 a year.

Requests for copies of the selective lists should be addressed to Reference Service, Office of Technical Services, Department of Commerce, Washington 25, D.C.

REVISIONS ANNOUNCED FOR NEMA MOTOR STANDARDS

A SECOND revision, consisting of revised printed pages, has recently been issued for the NEMA Motor and Generator Standards, Publication No. 45-102. Standards of particular interest cover the new "D" flange, the resistance method of temperature determination, integral-horsepower hermetic motors, and small-power motors for special applications.

The resistance method of temperature determination for large- and small-power a-c motors, single phase and polyphase, is now recognized as an optional method of temperature determination, and the applicable standards in the publication have been revised accordingly.

A new standard has been added covering the dimensions of integral hermetic motors for hermetic refrigeration compressors. Additional standards are now in the process of being developed for these motors.

Small-power-motor application standards included are: (1) motors for belted fans and blowers, (2) stoker motors, (3) cellar drainer and sump pump motors, (4) gasoline-dispensing pump motors, (5) oil-burner motors and (6) washing-machine motors. These are in addition to those contained in the first revision, which covered (7) hermetic motors, (8) belt-drive refrigeration compressor motors, (9) jet-pump motors and (10) motors for shaft-mounted fans and blowers.

Purchasers of the NEMA Motor and Generator Standards, Publication No. 45-102, (price $4.00), which includes all NEMA standards which have been issued for motors

COMING EVENTS

NAPE—National Association of Power Engineers, Annual Show and Convention; to be held August 25 through 28 with headquarters at Hotel Statler.

ASME—Fall Meeting of American Society of Mechanical Engineers; to be held in Salt Lake City, September 1 through 4, with headquarters at the Hotel Utah.

Instrument Society—Instrument Society of America annual meeting; to be held the week of September 8, 1947, with headquarters at the Stevens Hotel, Chicago.

Instrumentation Conference—Instrumentation Conference and Exhibit for 1947; to be held the week of September 8, with headquarters at the Stevens Hotel, Chicago.

ASME—Fuels Division Meeting of the American Society of Mechanical Engineers; to be held, October 6 through 8, in Houston, Texas. (Headquarters not yet announced.)

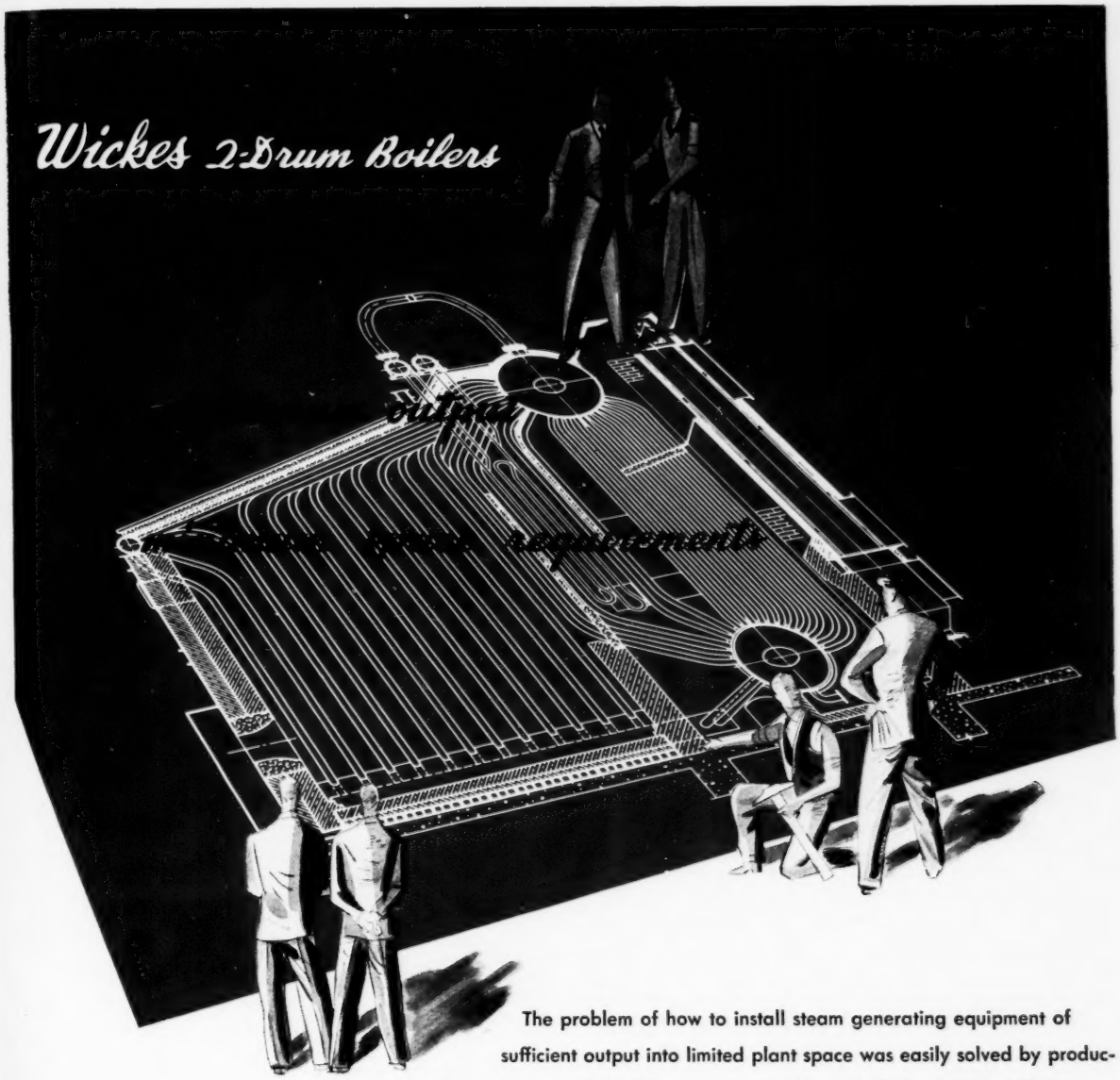
Hydraulics—Third Annual Meeting of the National Conference on Industrial Hydraulics (formerly the Hydraulic Machinery Conference); to be held October 16 and 17 in Chicago with headquarters at the Hotel Continental.

Water Conference—The 8th Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held in the William Penn Hotel, Pittsburgh, Pa. on November 12, 13, and 14.

Notice — Midwest Engineering and Power Exposition originally scheduled for November 15 through 20 has been canceled.

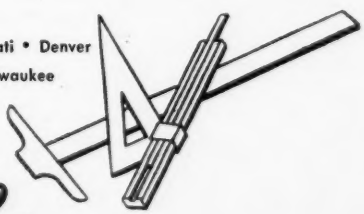
ASME—Annual Meeting of the American Society of Mechanical Engineers; to be held in either New York City or Atlantic City, N.J., December 2 through 5, Headquarters Chalfonte-Haddon Hall.

Refrigeration and Air Conditioning Exposition—Fifth All-Industry Exposition; to be held January 26 through 29, 1948 with headquarters at Cleveland Public Auditorium, Cleveland, Ohio.



The problem of how to install steam generating equipment of sufficient output into limited plant space was easily solved by production engineers of a rubber tire plant. They installed a Wickes 2-Drum Boiler, similar to the sketch reproduced here, and now they're getting top boiler efficiency at low operating and maintenance costs. If you have a similar problem in your plant, it will pay you to investigate Wickes 2-Drum Boilers. They are made for large and small industrial installations. Capacities up to 250,000 lb. steam per hour, pressures to 650 psi. Adaptable to all methods of firing. Wickes manufactures all types of multiple drum boilers. For complete information, contact your nearest Wickes representative or write direct.

SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cincinnati • Denver
Detroit • Fort Worth, Texas • Indianapolis • Jacksonville • Los Angeles • Milwaukee
New York City • Peoria, Ill. • Pittsburgh • Saginaw • San Francisco
San Jose, Calif. • Seattle • St. Louis • Tulsa, Okla. • Mexico City.



The Wickes Boiler Co.

THE WICKES BOILER CO. • SAGINAW MICHIGAN, U. S. A. • RECOGNIZED QUALITY SINCE 1854

and generators, will receive all revisions issued to this edition of the standard without charge until further notice. Requests for standards may be addressed to Electrical Manufacturers Public Information Center, 155 E. 44th St., New York 17, N.Y.

SMOKE PREVENTION GROUP TO MEET

THE FORTIETH Annual Meeting of the Smoke Prevention Association of America will be held on July 7-8-9-10 in Toronto, Canada, headquarters at the Royal York Hotel. It will be necessary for those attending to make early reservations, and in order to secure accommodations it is important that these reservations be made through the office of the Secretary. Write to: Frank A. Chambers, Sec'y., Smoke Prevention Association of America, 139 N. Clark St., Chicago 2, Ill.

SAFETY BOOKLET

A "TAKE HOME" booklet for industrial and office workers which warns against off-the-job accidents has just been published by the National Conservation Bureau, accident prevention division of the Association of Casualty and Surety Companies, 60 John St., New York 7, N.Y. The title of the pocket-size booklet is "Off-the Job Accidents and You."

Two main topics—traffic accidents and hazards in the home—are dealt with. The subjects under traffic include speeding, night driving, intersections, passing, alcohol and pedestrians. The home hazards include falls, burns and explosions, gas and electricity and poison. Safety tips on how to prevent accidents are given under each category.

B & W ELECTS KOHLER AND PHIN

THE BOARD OF DIRECTORS of The Babcock & Wilcox Co., have elected Anthony M. Kohler, and Alan E. Phin as Vice Presidents of the company.

Mr. Kohler joined the company in 1913 as production engineer and worked at the Bayonne, N.J. plant. When, in 1920, the company decided to engage in the manufacture of refractories, he was placed in charge of development work in that field. In that years, he started the Refractories Works for the company at East Liverpool, Ohio, where he served as superintendent. As the Refractories Division continued to expand, he was responsible for the development and construction of the Augusta (Georgia) Works and as a result was appointed General Manager of the Division in 1930. The Augusta Works is today one of the most modern plants for the manufacture of refractory products.

Mr. Phin joined the company in 1927 and has been in charge of accounting since that time. He received his training in Canada and is a member of the Institute of Chartered Accountants of Ontario, Canada. Before becoming comptroller for The Babcock & Wilcox Co., he worked in public accounting in New York City and was associated for some time with Barrow, Wade, Guthrie & Co. Mr. Phin is a member of the Comptrollers Institute of America. His home is in Scarsdale, N.Y.

NEW PLANT FOR MENGEL CO.

THE H. K. FERGUSON Co., industrial engineers and builders, announced recently that it has completed a new corrugated box manufacturing plant for The Mengel Co. at Fulton, N.Y.

The new plant is 400 ft long and 158 ft wide and contains approximately 70,000 sq ft of floor space. The building has brick, concrete block and steel sash walls. A structural steel frame supports a composition roof over a precast concrete slab. Outside bays in the plant are 20 by 45 ft while center bays are 20 ft by 60 ft. A boiler house was included as part of the project.

N.E.C. PROCEEDINGS AVAILABLE

THE PROCEEDINGS of the 1946 National Electronics Conference has been printed and is now available, at $3.50 a copy, from R. E. Beam, Secretary, NEC, Electrical Engineering Dept., Northwestern University, Evanston, Ill. Copies of the 1944 Proceedings are also available at $3.00 a copy.

The 1946 Proceedings contains a total of 741 pages, including a complete list of registrants and exhibitors at the 1946 Conference. Brief bibilographies of all authors presenting papers, and photographs of most of them, are included.

ELECTRONICS MEETING EVENTS PLANNED

AMONG THE events being planned for the 1947 National Electronics Conference, to be held at the Edgewater Beach Hotel, Chicago, on November 3, 4, and 5, are three luncheons and a banquet, all of which will be addressed by nationally-known speakers.

These functions will be held in the Marine Dining Room. One of the luncheons is to be under the auspices of the American Institute of Electrical Engineers, while the Institute of Radio Engineers will be in charge of another. Both of these organizations are sponsors of the Conference.

A program of between 50 and 60 technical papers, covering all phases of electronics, will feature engineers who are recognized authorities in their respective fields. A portion of this program is being arranged by the Electronics Section of the AIEE in connection with the AIEE Fall Meeting in Chicago, with the IRE sponsoring another portion.

According to preliminary figures announced by the Federal Power Commission, electric operating revenues of the larger privately-owned electric utilities in the United States for the first quarter in 1947 were $912,135,000 compared to first quarter 1946 revenues of $819,912,000, an increase of 11.2 per cent.

Herman C. Hesse has been named professor of mechanical engineering at Illinois Institute of Technology, Pres. Henry T. Heald has announced. The appointment is effective September 1. Mr. Hesse is now chief engineer in charge of design, research, and production of the Mixing Equipment Co., Rochester, N.Y.

Obituaries

WM. G. HICKLING

WILLIAM G. HICKLING of Binghamton, vice-president and general manager of the New York State Electric & Gas Corp., recently died of a cerebral hemorrhage at Memorial Hospital in Syracuse. He was 50. Mr. Hickling, who headed operations of the company in 43 upstate counties, had gone to Syracuse on a business trip.

Mr. Hickling came to Binghamton from Erie, Pa., in April, 1941, when he took charge of operations and construction for the utility. The construction program included the building of a plant at Bainbridge, expansion of the Westover plant and other projects still pending.

He coordinated the firm's operations throughout the area served by the company which includes parts of 43 upstate counties, and supervised its power stations and transmission lines. He also directed the work of the company's five divisional managers.

Born Feb. 19, 1897, at Wallingford, Conn., Mr. Hickling spent most of his childhood and youth in Dawson, Yukon Territory, Northwest Canada, with his parents. He was graduated from Dawson High School and in 1917 from Sheffield Scientific School at Yale University. From August, 1918, until the following December, he served with the army signal corps. Mr. Hickling joined the Penn Public Service Co. at Johnstown, Pa., as an engineer Oct. 10, 1919.

In 1936 he became vice-president and general superintendent of operations of the Pennsylvania Electric Co. of Johnstown. The following year he moved to Erie and was made president of the firm's affiliate, the Erie Lighting Co., at the same time continuing in the other post. Until he came to Binghamton, he also was a director of the Keystone Public Service Co. of Oil City, Pa.

Surviving Mr. Hickling are his wife, the former Marguerite Earlenbaugh, of Binghamton; a son, W. Fred Hickling, an engineering student at Cornell University; his mother, also of Binghamton, and a brother, Fred Hickling, manager of the Cleveland office of Westinghouse Electric Corp.

MILTON ROY SHEEN

MILTON ROY SHEEN, president and co-founder of the Milton Roy Co., pump manufacturers, died recently in his home in suburban Glenside, Pa., at the age of 63.

Mr. Sheen designed the chemical pumps made by his firm and also was widely known as an inventor. Among his inventions were a diving bell, tunnel machine and clamshell excavator. In 1919, the Franklin Institute awarded to him the Edward Longstreth Medal for Meritorious work in science and invention.

Born in South Montrose, Pa., he was educated in the schools there and attended the State Normal School at Bloomsburg, and Temple University. He was a former deacon of the Tioga Baptist Church in Philadelphia and was a member of Concordia Lodge, No. 17, and Vulcan Assembly, both Masonic organizations.

Mr. Sheen leaves a widow, Mrs. E. Elizabeth Sheen; two sons, Robert T. and Milton R., and two daughters, Mrs. Evelyn Murray of Portland, Ore., and Mrs. Mildred L. Lissow of Spencerport, N.Y.

PELL W. FOSTER

PELL WILLIAM FOSTER, 84, director and former vice president of the Foster-Wheeler Corp., died recently on a train near Liberal, Kan., while enroute to New York from his home in Tucson, Ariz.

Mr. Foster was accompanied on the train by his daughter, Mrs. Irving S. Olds, wife of the chairman of the board of the United States Steel Corp.

A native of New York City, Mr. Foster attended Browning School and the School of Mines of Columbia University, from which he was graduated in 1883. He was associated for several years with the New York brokerage firm of Brown Brothers & Co. He later assisted in the development of the Retsof salt mine, now a part of the International Salt Co.

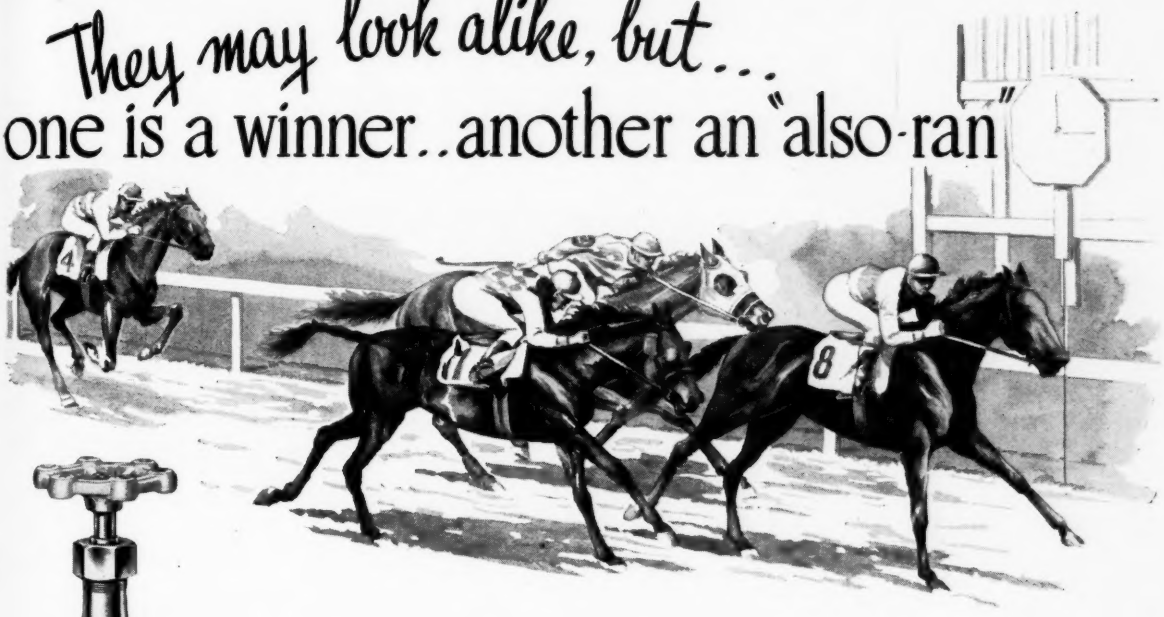
In 1900 Mr. Foster founded the Power Specialty Co., machinery manufacturers. He was its president for twenty-seven years. During this period, in association with his cousin, Ernest H. Foster, he developed the Foster steam superheater.

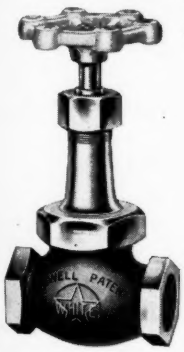
Mr. Foster was president of the Destructor Co., which built refuse disposal plants in numerous cities. During World War I, when he was an executive of the Foster Wheeler Corp., the concern designed a special marine boiler which was installed in hundreds of ships.

Surviving, in addition to Mrs. Olds, is

(*Continued on page 144*)

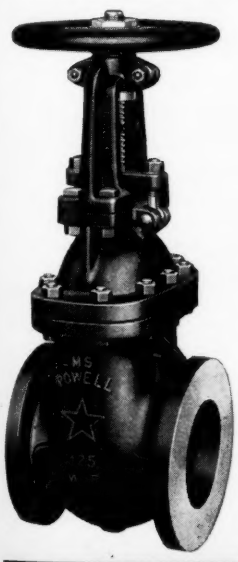
They may look alike, but...
one is a winner..another an "also-ran"





Small size 200-pound Bronze Globe Valve for steam, water, oil or gas. For assured, long-life performance it has a renewable, specially heat treated stainless steel seat; a regrindable, renewable, wear-resisting "Powellium" nickel-bronze plug type disc.

Class 1500-pound Cast Steel Welding End Gate Valve with POWELL PATENTED PRESSURE SEAL BONNET. The internal pressure seals body-bonnet joint. Anti-friction bearings in yoke.



Large Iron Body Bronze Mounted Gate Valve for 125 pounds W. S. P. Made in sizes 2" to 30", incl. Has flanged ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Taper wedge double discs can be provided in sizes 2" to 12", incl. Also available in All Iron.

Call it "heart", "staying power", or what you will, some thoroughbreds have what it takes to win.

Now let's consider valves!

Compare the outward appearance of any Powell valve with that of other valves of the same type and size. You'll probably see very little difference. *It's the things you don't see that give Powell valves the "staying power" that makes them winners.*

There's nothing mysterious about these things. They're merely the result of the continual progress in design, knowledge of materials, and quality of workmanship that comes from more than a century of making valves—and valves only—for American industry.

The Wm. Powell Company
Cincinnati 22, Ohio
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

STOP WORRYING ABOUT FIRE!

Get EVERLASTING VALVE *protection*

Here are two valves you can *depend on* for protection of your property when fire threatens. Weight-operated with pendulum stop — controlled thermostatically, electrically, or manually — they provide instant action for instant protection.

Available in both opening and closing types, these Everlasting Valves are suited for Dip Tank Discharge, Fuel Oil Shut-off, Foam and other Fire Protection Systems.

For emergency shut-off of inflammable liquids, or to concentrate water or steam in fire mains, specify the *Closing Type* Everlasting Valve (Fig. 4831 BC).

For diversion of water to sprinkler deluge or water curtain systems, or to divert inflammable liquids to a safe point, specify the *Opening Type* Everlasting Valve (Fig. 4721 BC).

Positive in action, these Everlasting Valves provide instant, unfailing protection when released. They will not stick because their materials will not corrode in use. They will not bind because there is no external stuffing box. They will not wedge because the disc action parallels the valve seat. Straight-through design permits a full unimpeded flow.

What's more, no pendulum swing-stop is necessary. At bottom of its swing, the weighted pendulum is disengaged from the valve mechanism . . . there's no possibility of valve fracture due to impact.

For all details on these Everlasting fire protection valves, send for our Bulletin E-52 C — *today!*

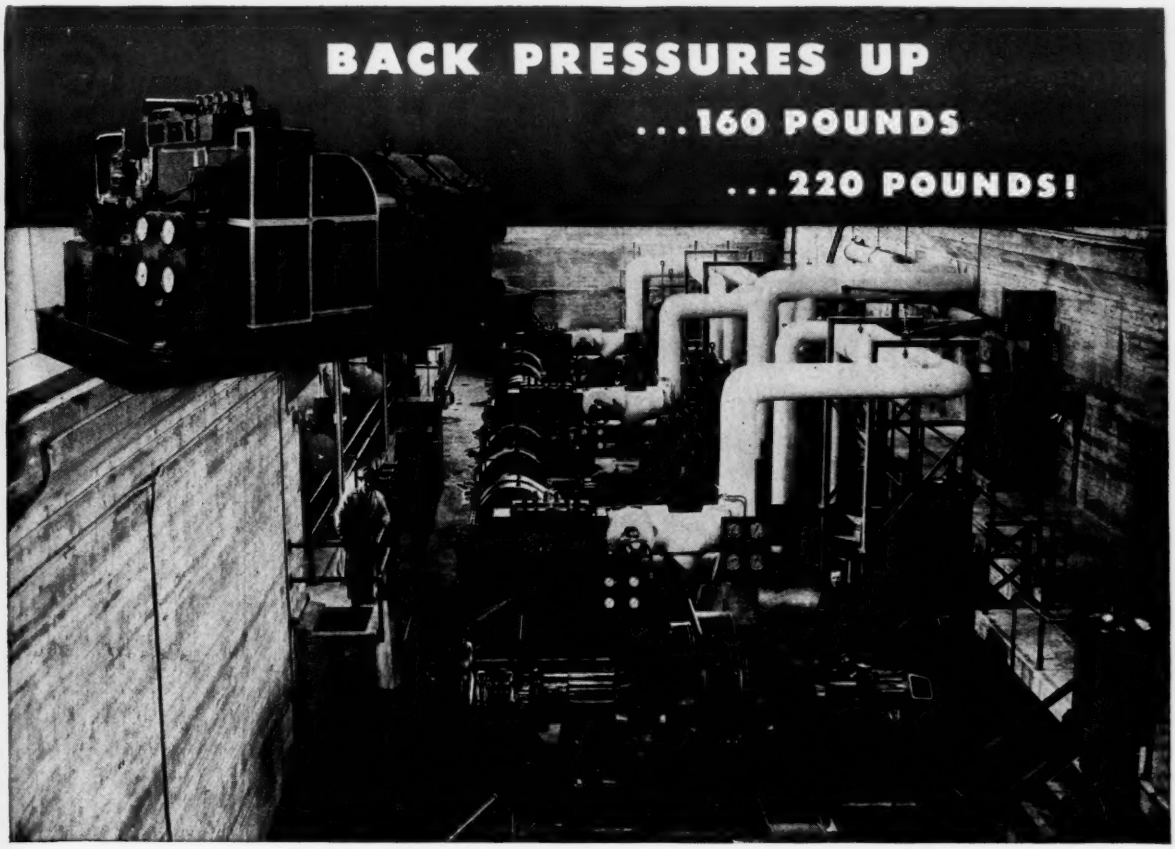
Manufactured by

EVERLASTING VALVE COMPANY

49 Fisk Street, Jersey City 5, N. J.

Trade-Mark "EVERLASTING"—REG. U. S. PAT. OFF. EV-330

EVERLASTING VALVES *GIVE "EVERLASTING" SERVICE*



Result: Lowest power costs at new synthetic rubber plant with Worthington-Moore turbines

In Canada's new government-owned synthetic rubber plant, operated by Polymer Corporation, Ltd., Worthington-Moore high back pressure steam turbines have permitted considerable savings in power costs. In this, Canada's largest steam plant installation, engineered by H. G. Acres and Company, power is produced as a by-product, since all exhaust steam is used for plant operation.

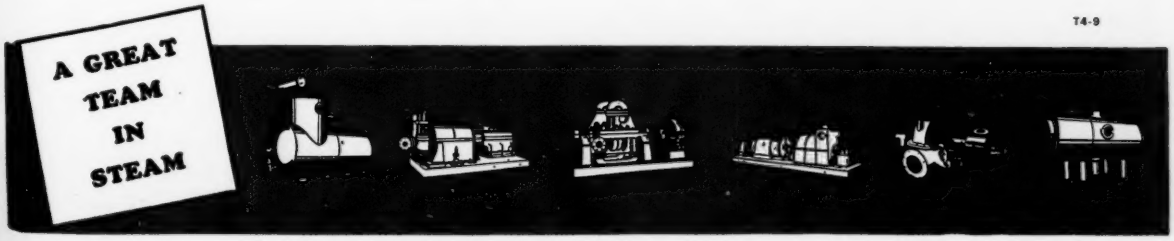
Three Worthington-Moore 1650-hp. geared multistage turbines are illustrated above as installed. These topping turbines operate with steam at 400 lbs. initial pressure, 650°F. temperature, and exhaust against 160 lbs. back pressure. Two 1000-hp. Worthington-Moore turbines, exhausting to 220 lbs. back pressure, were also selected.

Save Money in Modernizing Steam Plants

Worthington-Moore turbines operating against unusually high back pressures have enabled many plants to install modern high-pressure boilers without scrapping existing low-pressure apparatus. Write for complete details. *Worthington Pump and Machinery Corporation, Moore Steam Turbine Division, Wellsville, New York.*

WORTHINGTON

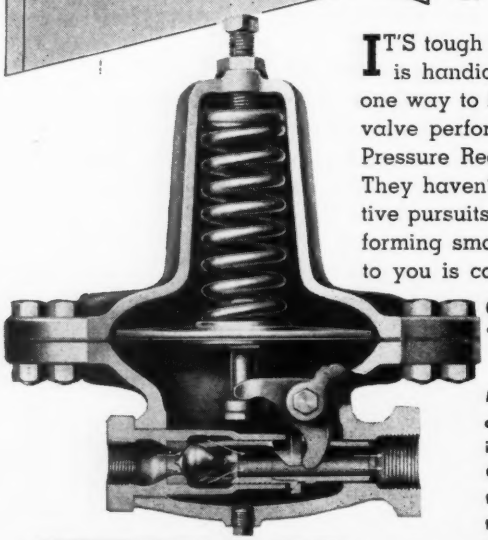
T4-9



IT TAKES MORE THAN THIS TO KEEP 'EM OUT

INSTALL THESE TO INSURE AGAINST SUCH COST MAKERS

CASH STANDARD Streamlined PRESSURE REDUCING VALVES TYPE 1000



IT'S tough going and costly too when production is handicapped by these six culprits. There is one way to fully protect against them as concerns valve performance. The "Streamlined" Type 1000 Pressure Reducing Valve ties 'em hand and foot. They haven't a chance to engage in their destructive pursuits with the Type 1000 on your lines performing smoothly and dependably. The net result to you is continuous savings and no trouble.

Our bulletin "962" gives you the entire "1000" story.

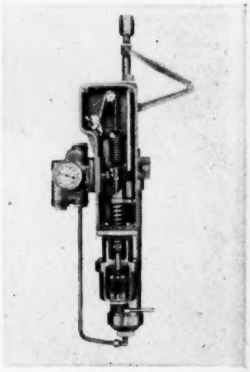
Maximum Capacity When Needed Most • Accurate Pressure Control Under Toughest Working Conditions • Trouble-Free Service • Smooth Operation • Tight Closure • Accurate Regulation • Speedier Production Results • Elimination of Failures • Constant Delivery Pressure • Cost Saving Operation • No Spoilage • Practically Zero in Maintenance Costs.

CASH STANDARD CONTROLS... VALVES

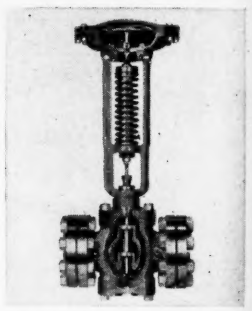
A. W. CASH COMPANY
DECATUR, ILLINOIS

BULLETINS AVAILABLE ON OTHER CASH STANDARD VALVES

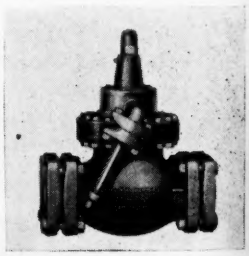
Send for them



Bulletin 963 features the CASH STANDARD Type 100 Series of Super-Sensitive Controllers — various types for automatically operating valves, dampers, rheostats, stokers, pulverizers, fans, and other apparatus. 16 pages filled with descriptions and applications.



Bulletin 968 features the CASH STANDARD Type 34 Pressure Reducing Valve — direct operated — direct acting for handling steam, hot water, cold water, air, oil, brine—and most liquids and gases except some injurious chemicals. Illustrates and describes the different styles available and tells about their applications. Three pages of capacity charts.



Bulletin 956 features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.

ANTICIPATING THE NEED...

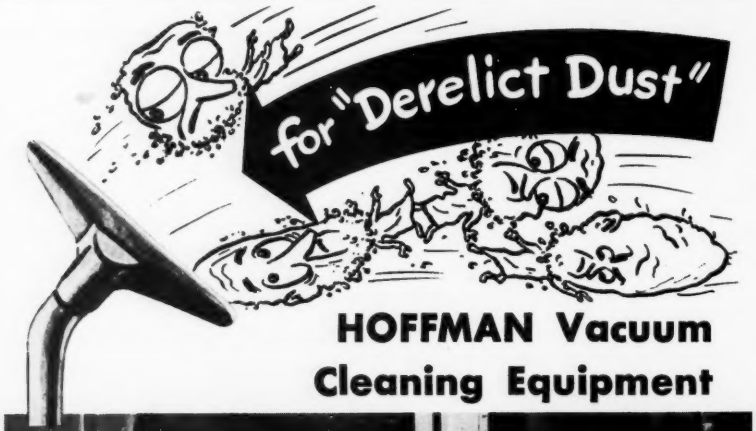
Our current work for Public Utilities includes design and construction of 23 power stations and power plant extensions and 220 miles of transmission lines. These installations will make available 1,673,000 KW of additional power to supply the needs of fast growing industrial and farming areas.

Mississippi River Crossing Tower and Louisiana Power Station of the Gulf States Utilities Company in Baton Rouge.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

IT'S THE BUMS' RUSH



HOFFMAN Vacuum Cleaning Equipment

No scattering of dust here! Hoffman Vacuum Cleaning Equipment removes it completely, quickly.

Light, free-flying dust or deep, heavy imbedded deposits — *both* are removed swiftly, completely and economically with Hoffman Vacuum Cleaning Equipment. Swiftly, because your Hoffman system goes to work instantly, even during plant operation . . . completely, because powerful suction and special tools grab up all dust on walls, floors, structure and hard-to-reach areas. And, economical because you save clean-up time and manpower — as well as productive efficiency.

GET A FREE SURVEY

Hoffman specializes in vacuum cleaning systems for industries. Four sizes of portable units. All sizes of stationary systems, with permanent piping, to fit your plant's special requirements. Ask for a Free Engineering Survey — without obligation — *today*.

U. S. HOFFMAN MACHINERY CORPORATION
AIR APPLIANCE DIVISION, 101 FOURTH AVE., NEW YORK 3, N. Y.

OBITUARIES

(*Continued from page 138*)

a son, Pell W. Foster, Jr., of Englewood, N.J., vice-president and a director of the Foster Wheeler Corp.

MARTIN INSULL

MARTIN J. INSULL, younger brother of Samuel J. Insull, died recently in a hospital in Orillia, Ontario, Can., the town wherein he had sought seclusion following the collapse of the Insull holdings in 1932.

Mr. Insull, who had been in failing health for nearly two years, was 77 years of age. Born in England in 1869, Mr. Insull came to the United States in 1887 and was graduated from Cornell University in 1893, worked for a short time with an electrical engineering firm and in 1904 was sent by his brother to New Albany, Ind., where he became president of the United Gas & Electric Co., The Louisville & Northern Railway and Light Co. and the Louisville and Southern Indiana Traction Co. These companies were the nucleus of the Middle West Utilities company which was formed in 1912 with Martin Insull as Senior Vice President in charge of operations.

As the Insull empire expanded he became director in many of its subsidiaries. He became president of the company in 1924 after his brother was elevated to chairman of the board; he retained the active leadership of the company until 1932.

JOHN R. ALPINE

J. R. ALPINE, assistant to the president of Grinnell Co., Inc., died recently at his home in New York City. He was 79 years of age.

Mr. Alpine was born in Portland, Me., and later moved to Boston as a young man, where he found work as a steamfitter. He joined the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry, A.F. of L., and within a few years became president of the local in Boston.

In 1906 he was elected president of the international union and also became head of the Building Trades Council of Boston. He was elected vice-president of the A. F. of L. in 1912 and during World War I was acting president while Samuel Gompers was in Europe. He retired in 1920.

He was an adviser on labor policies to both the War and Navy Departments during World War I and was a labor delegate to the Paris Peace Conference in 1918.

His business career began in 1920 when he became assistant to the president of the Grinnell Company, which has its home office at Providence, R.I. He later was elected to the companys board of directors and was also chairman of labor relations for the National Automatic Sprinkler and Fire Control Association. During World War II he was adviser to the Labor War Policy Board in Washington.

His wife, Mrs. Frances Welch Alpine, died in Washington in 1932. Surviving are his son, Leo J. Alpine; two daughters, Mrs. Alice M. Alpine and Mrs. Anne A. Beauchamp, and a brother, George W. Alpine.

E. L. BERRY

E. L. BERRY, vice president in charge of production, Link-Belt Co., Chicago, died recently, from a heart attack, at the age of 52.

Mr. Berry began his Link-Belt career in 1914, as machinist, at the company's Pershing Road plant in Chicago, after having

STEAMASTER is the BOILER WITH PLENTY OF GUTS!

WATER TUBE DESIGN

INCLINED TUBES

SECTIONAL STEEL HEADERS

LONGITUDINAL DRUM

THE GUTS of the Steamaster Boiler

Steam is water plus heat

It is **how** that heat and water are utilized that makes a boiler good or bad. Now take a look at the guts of the Steamaster Boiler — the famed water tube principle, combined with sectional steel headers and inclined tubes gives you a superior design resulting in high thermal efficiency and economical maintenance . . . at no greater cost than an average so-called "packaged" boiler.

Yes... Steamaster Boilers have the guts that enable them to be fired over their rated capacity with no loss in efficiency — the guts to keep on economically filling your steam requirements year after year.

POWER ENGINEERS AGREE . . .

STEAMASTER IS THE BOILER WITH PLENTY OF GUTS!

Steamaster

AUTOMATIC BOILER CO.

Compton at Slauson Ave., Los Angeles 11

SALES AND SERVICE IN ALL PRINCIPAL CITIES

The advantages of a WATER TUBE BOILER designed the Steamaster Way

EASY INSPECTION AND MAINTENANCE Every tube immediately accessible. Just open the heavily insulated access doors.

LARGE COMBUSTION AREA . . . THREE PASS HEAT BAFFLING . . . Gives high thermal efficiency — economical consumption of fuel.

POSITIVE TIDAL CIRCULATION OF WATER Maintains all parts at equal temperature.

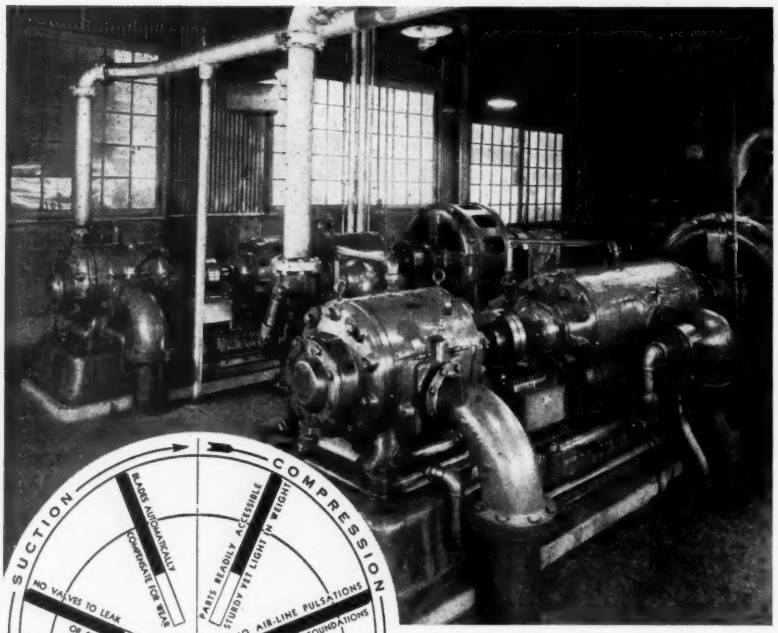
CONDENSATE RETURN SYSTEM BUILT-IN as an integral part of all boilers of 60 h.p. and up.

CHOICE OF FUEL — GAS, OIL OR COAL Whatever your fuel requirement is, there is a Steamaster Boiler to fill it. Use Gas, Oil or Coal or any combination.

FULL RANGE OF SIZES from 10 to 300 h.p. as illustrated. The Model A for 3½ h.p., 5 h.p. and 7½ h.p.

FULLY EQUIPPED FOR AUTOMATIC OPERATION . . . finest accessories.

A.S.M.E. CODE—NATIONAL BOARD APPROVED . . . Inspected and certified by Hartford Steam Boiler Inspection and Insurance Co.



SIMPLICITY!

FEWER MOVING PARTS TO WEAR
NONE TO ADJUST

Simple design—simple operation—rugged construction for long, continuous service, that's what you get when you purchase a Fuller Rotary Compressor. No periodical adjustments or take-up and, due to its design and construction, original capacities are maintained for the life of the machine.

When these machines do require inspection or repairs, they're so constructed that the work can be done with minimum loss of time and expense.

Fuller Compressors are built in single and two-stage types, capacities to 3300 c.f.m., 125-lb. pressure. Vacuum pumps for vacuums to 29.90-in. (referred to 30-in. barometer).

Write for Bulletin C-5 illustrating and describing these machines.

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago 3 - 120 So. LaSalle St.
San Francisco 4 - 421 Chancery Bldg.

C-141

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

been graduated from Williamson Trade School, and successively held the positions of rate setter, sub-foreman of shop, head of time study department, works engineer, general superintendent, asst. general manager.

During the war, Mr. Berry was vice-president and general manager of the wartime subsidiary Link-Belt Ordnance Co., now dissolved.

He became vice-president of the parent organization, Link-Belt Co., on Jan. 1, 1944. He was also a vice-president and director of Link-Belt Speeder Corp.

PAUL T. PAYNE

PAUL T. PAYNE, 67, District Manager of Dearborn Chemical Co., Indianapolis, Indiana,, died recently at Witham Hospital in Lebanon, Indiana, in which city he resided for more than six years.

Forty-nine years ago Mr Payne became associated with the Dearborn Chemical Co. as a laboratory technician. This qualified him to assume the responsibility of various positions in the Sales Department, starting in the Chicago office, later as Manager of the Philadelphia office, and for the past 36 years as District Manager of Indianapolis office, covering the south and eastern part of the United States.

During the years Mr. Payne was well known for his very active membership in the American Gas Association and Power and Plant Engineers Association.

He was a member of the board of trustees of the Presbyterian Church in Lebanon, a member of Masonic Lodge, Medinah Shrine Temple and Scottish Rite in Chicago. Mr. Payne was a charter member of Indianapolis Athletic Club and a member of Columbia Club, having lived in Indianapolis 30 years before moving to Lebanon.

Survivors include the widow, Mrs. Mahlon B. Bayley Payne; and two children, Paul Bayley Payne, Indianapolis, and Phyllis M. B. Payne, New York City.

MANUFACTURERS' *News*

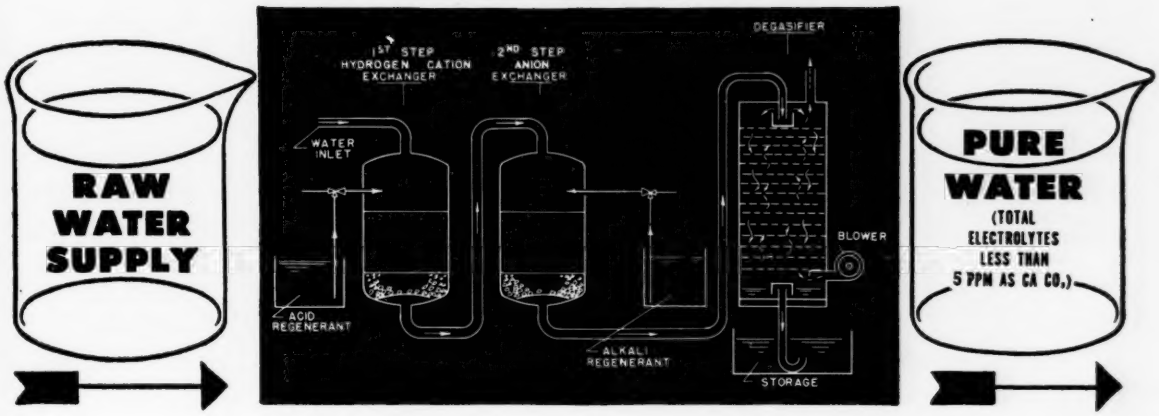
WARREN STEAM PUMP OBSERVES FIFTIETH ANNIVERSARY

WARREN, MASSACHUSETTS, has always been a "Pump Town" . . . at least for several generations . . . the first pumps manufactured here being of the hand variety back early in the nineteenth century. Steam pumps came in 1859, and from a two-man project was developed the Knowles Steam Pump Works, employing some 400 to 500 hands, afterward to be affiliated with George F. Blake Manufacturing Co. of Boston, and removed to East Cambridge, Massachusetts. This left the town minus its main industry and in February, 1897, the Warren Steam Pump Co. had its humble beginning, sponsored by former skilled Knowles Co. workers and a group of influential citizens.

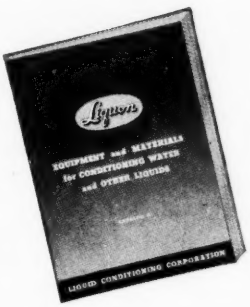
During the first several years, reciprocating pumps were the sole product of the company, and into them went the skill of determined New England craftsmen . . . whose main objective was to build the best possible pump. Constant research and development speeded the accomplishment of this purpose and the business prospered, making expansion of plant and facilities necessary as distribution increased. In 1902, the first section of what is now the main machine shop was built. Additions have been made from time to time until this unit is now nearly 700 ft long and contains the most modern facilities for the production of both reciprocating and centrif-

LIQUON

DEMINERALIZING PROCESS



SIMPLE...RELIABLE...ECONOMICAL



For boiler feed . . . for process work . . . for laboratory use . . . investigate the LIQUON Demineralizing process to obtain purer water at lower cost. Write for Catalog G, and your request for complete information will not involve the slightest obligation.

"DEMINERALIZE" . . . *to remove minerals* . . . that's exactly what the LIQUON Demineralizing Process does to your raw water supply. This process eliminates both hardness and alkalinity, and reduces the total dissolved solids down to practically zero. The result . . . the equivalent of most distilled water, and at a fraction of the cost of distillation.

HOW THE LIQUON DEMINERALIZING PROCESS OPERATES

In this two-step process, the raw water passes first through a LIQUON Hydrogen Zeolite Unit. Here, the salts present are converted into their corresponding mineral acids as the water flows through a bed of acid-regenerated LIQUONEX CR, a resin type of cation exchange material. The effluent from this stage then passes through a LIQUON Anion Exchange Unit, where the mineral acids are removed by the alkali-regenerated LIQUONEX A, a high-capacity anion exchange resin. Carbonic acid (carbon dioxide) is then removed by aeration in a LIQUON Degasifier or Decarbonator. Silica may also be removed where desired by adding fluorides or by a third step anion unit. The process is simple . . . the equipment is compact . . . the operating cost is frequently far less than one-tenth the cost of distilling water.

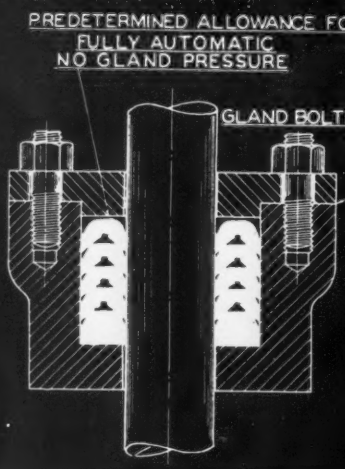
LC-120

LIQUID CONDITIONING CORPORATION

114 East Price Street, Linden, N. J. • *Engineering Service Representatives in Principal Cities*

Liquon

EVERY PROCESS...EVERY TYPE OF EQUIPMENT
for Conditioning of Water and Other Liquids



YOUR "Best Bet" ON HIGH PRESSURE PUMPS AND STEAM ENGINES

CHOOSE THE PACKING THAT'S *Fully Automatic*

As shown above PARACHUTE PACKING is installed in the stuffing box without gland pressure . . . This construction feature means that PARACHUTE is automatic, truly automatic. The operating pressure does the work on the energy stroke . . . and only then . . . friction is reduced 50%. No after-adjustments simplifies the maintenance of hydraulic rams, steam engines, air compressors and other heavy duty units . . . Write for the Chesterton PARACHUTE Engineering Folder; it will give you a new slant on what you should be getting when you buy packings.

CHESTERTON
Parachute Packing

A. W. CHESTERTON CO.
9 ASHLAND ST., EVERETT STATION, BOSTON 49, MASS.

"Boiler Repairs Reduced 75%"
writes user of NATIONAL GIRTH SEAM PROTECTOR

We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 928-29 REIBOLD BLDG., DAYTON, OHIO

ugal pumps, a complete line of the latter having been added in 1924.

Warren's war effort record was an enviable one, in recognition of which they were awarded the Army-Navy "E." But it has been during peace times that the company's reputation has been so firmly established, a position gained by the ingenuity and experience of its men and the efficiency of its methods.

NEW APPOINTMENTS BY CARBORUNDUM

PRESIDENT H. K. CLARK of The Carborundum Co., Niagara Falls, N.Y. has announced the appointment of Clarence E. Hawke as Drector of Domestic Sales; Edwin B. Forse as Manager of The Carborundum Refractories Division at Perth Amboy; Boyd H. Johnson as Manager Refractories Sales at Perth Amboy and Russell G. Albertson as Division Manager Canadian Carborundum Co., Ltd., Niagara Falls, Ontario.

The appointment of Mr. Hawke as Director of Domestic Sales of the company, is in keeping with a plan to coordinate, more closely, all sales activities under the functional direction of Vice President and General Sales Manager, F. J. Tone, Jr. Mr. Hawke, reporting to Mr. Tone, will direct all domestic sales activities including those of the Refractories and Globar Divisions as well as the Canadian Carborundum Co., Ltd. Division.

Mr. Hawke was born in the United States and received his early education in England, where his father the late Martin Hawke was managing director of the Carborundum Co. at Manchester. In 1910 he went to the Deutsche Carborundum Werke at Dusseldorf, Germany as assistant to the works manager and later was appointed superintendent of that plant. In October 1923, he came to Niagara Falls to spend a year in studying manufacturing and sales methods of the American Plant. As the outbreak of World War I he was assigned to the sales department and was highly instrumental in organizing the Carborundum sales engineering department.

In 1916 he entered the service and was stationed in England as a second lieutenant in the aviation engineering corps. Returning to Niagara Falls in 1919, he pioneered with the late Dr. Frank J. Tone, Sr., formerly president, in the development of refractories, and in 1920 he was appointed sales manager of the Refractories Division at Perth Amboy, N.J. from which post he now returns to Niagara Falls as Domestic Sales Manager.

RAYBESTOS-MANHATTAN ADVANCEMENTS

AT THE ANNUAL meeting of Raybestos-Manhattan, Inc. held recently two vice presidents and a director were added. Those promoted are: John H. Matthews elected vice president in charge of the Manhattan Rubber Division, Passaic, New Jersey; O. H. Cilley, assistant general manager of the United States Asbestos Division, Manheim, Pennsylvania, was made a vice president; A. F. Heinsohn, general manager of General Asbestos and Rubber Division, North Charleston, South Carolina was placed on the new Board of Directors. All of these men have come up from the ranks in their respective Divisions and have served many years.

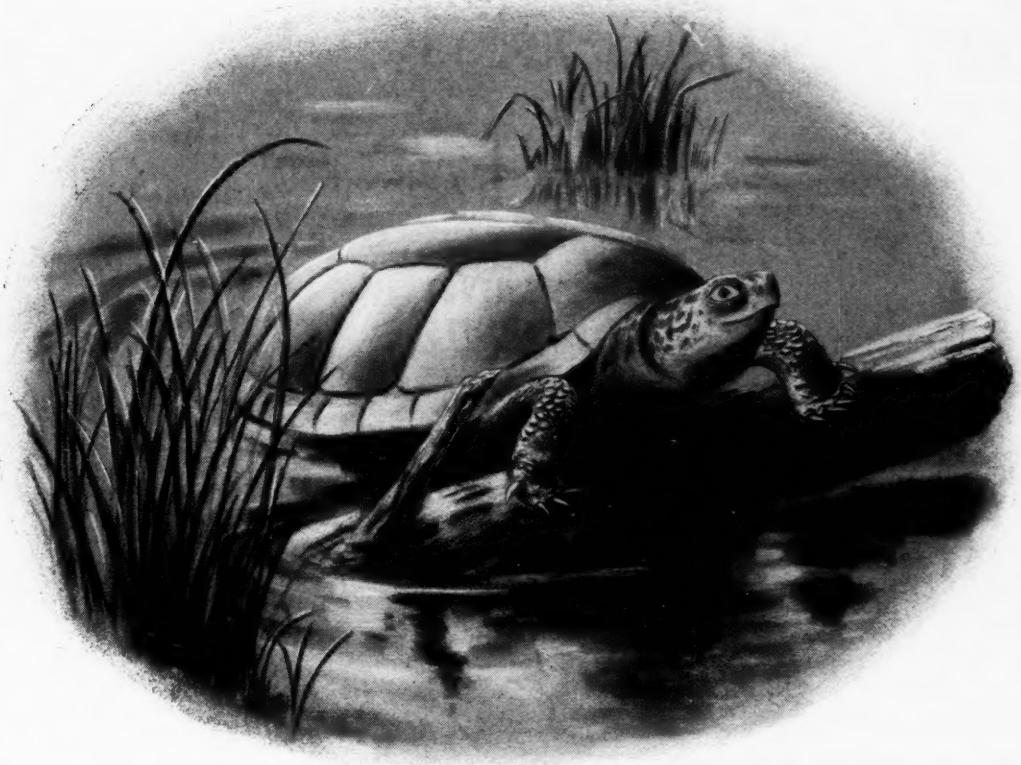
NEW LESLIE AGENTS

LESLIE CO., Lyndhurst, N.J. has announced the appointment of the following agents to handle industrial sales and service: Plant Equipment, Inc., Minneapolis, Minn.; Fluid Equipment Co., Dallas, Texas; Avery M. Walsh & Sons, Albany, N.Y.

BAILEY METER CO. ASSIGNS FIELD ENGINEERS

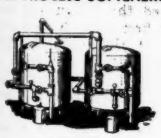
BAILEY METER CO., Cleveland, has announced the assignment of three engineers to the company's branch offices. R. L. Stewart reports to Denver and L. E. Bartel to Kansas City. G. D. Williams is being assigned to Atlanta after temporary duty in Boston.

Mr. Stewart was graduated from Iowa

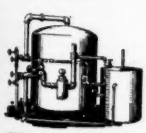


TURBIDITY IS GREAT FOR TURTLES

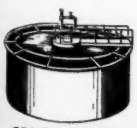
HOT PROCESS SOFTENERS



FILTERS



ZEOLITE SOFTENERS



REACTIVATORS

Turtles may feel at home in turbid water. Industry, however, takes a different viewpoint.

When boiler feed, process or cooling water must be taken from a source carrying excessive turbidities, the most successful conditioning can be accomplished with a Graver reactivator. This equipment, which consists of a single tank, clarifies the water by passing it through a sludge blanket, and to a degree, removes hardness, iron, silica and other impurities. Installed in connection with other Graver equipment, it delivers a water suitable for boiler feed or any other purpose where turbidity-free water is required.

For maximum economy of initial investment and operation . . . for definite savings in space and conditioning time . . . specify the Graver reactivator. Bulletin 325 gives the complete story of the reactivator. Get this, or details on other Graver water conditioning equipment, today. Call or write your nearest Graver office.

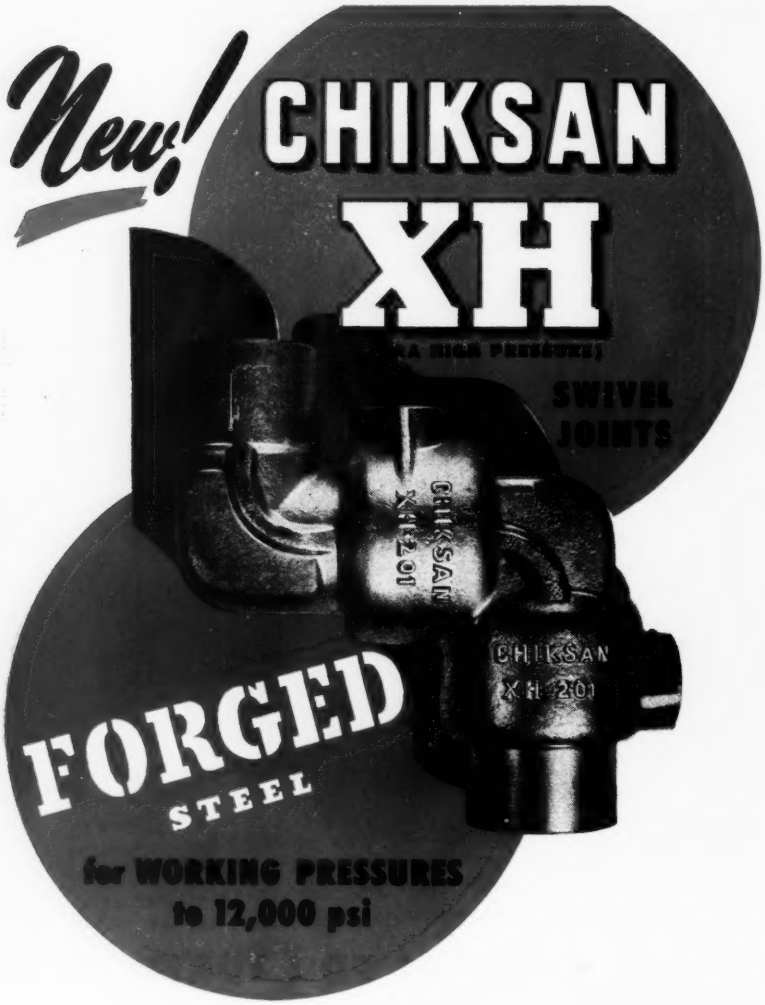
GRAVER TANK & MFG. CO., INC.

General Offices: East Chicago, Indiana

New York Philadelphia Chicago

Water Conditioning and Process Equipment Division

GRAVER



The new forged steel CHIKSAN XH Swivel Joint combines the easy turning and effective pack-off — for which all CHIKSAN Joints are noted — with high capacity. Built of forged steel, with flame-hardened races, this new CHIKSAN Joint is designed for heavy duty services of all kinds. It makes possible the fabrication of all-steel lines with perfect flexibility, yet capable of withstanding working pressures to 12,000 psi... with greater safety and longer life. Engineering data on request.

In addition to the new CHIKSAN XH forged steel Swivel Joint, there are over 500 different Types, Styles and Sizes available for pressures from 300 to 3000 psi, and temperatures to 500° F.

REPRESENTATIVES IN PRINCIPAL CITIES

EXPORT REPRESENTATIVE: Chiksan Export Co., Brea, Calif.

Branches: New York 7, Houston 2

CHIKSAN

BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN COMPANY

BREA, CALIFORNIA

New York 7 Houston 2

State College as a mechanical engineer. Mr. Bartel was graduated from the University of Minnesota with a degree in naval science. Mr. Williams is a graduate of Worcester Polytechnic Institute. His degree is in mechanical engineering.

All of these men served as naval officers during the war and joined Bailey Meter Co. shortly after their discharges. They recently graduated from the Cadet Engineering Course at the company's Cleveland factory. This course consists of the theory of measurement, combustion, and automatic control as it applies to power plants and industrial processes. They have also had experience in assembling, calibrating and servicing Bailey equipment.

HARTER CHAIRMAN B & W TUBE CO.

A. G. Pratt, President of The Babcock & Wilcox Co. and The Babcock & Wilcox Tube Co., has announced that Isaac Harter has been elected Chairman of the Board of the Tube Company, Beaver Falls, Pa., and will henceforth give his undivided attention to its development. Accordingly, he retired from his position as Vice President and Director of The Babcock & Wilcox Co. on April 1.

Mr. Harter joined The Babcock & Wilcox Co. in 1907. He was Superintendent of its Barberton (Ohio) Works, 1907-10; Superintendent of its Bayonne (N.J.) Works, 1910-20; and Assistant to the President, 1920-1924. He has been a Vice President and Director of The Babcock & Wilcox Co. since 1924, and has served as Executive Vice President and Director of the Tube Company.

With the election of Mr. Harter to the chairmanship of the Tube Company Board, P. D. White becomes Executive Vice President of the Company. Mr. Pratt is President and C. W. Middleton, Vice President.

FERGUSON BUILDING FOR STALEY MFG. CO.

The A. E. Staley Manufacturing Co. has awarded a large contract to The H. K. Ferguson Co., for modernization and expansion of its corn refinery plant at Decatur, Ill.

The major portion of the work will be the creation of additional processing facilities. Corn grind capacity of the plant will be increased from its present level of 50,000 bushels daily to 75,000 bushels.

Most of the increased capacity, according to Staley officials, will be used in the manufacture of "sweetose," an extra-sweet syrup made by a patented dual-conversion process involving the use of enzymes. The remainder of the additional capacity will be used in making special starches for use in the textile, paper and other industries.

Contracts awarded to The Ferguson Co. cover engineering, construction and equipment installation. Preliminary design has already started.

FIRST DUAL FUEL DIESEL COMPLETES RUN

Early in 1945 Worthington Pump & Machinery Corp. announced the design and construction of the world's first supercharged dual fuel Diesel. In April of this year the first commercial unit was placed in operation in the municipal power plant at Lamar, Colorado. Field acceptance tests successfully met the guarantee and the unit took its place in the daily operating schedule of the power plant.

The company points out that the ability of this engine to burn oil or gas fuel in any proportion and with highest sustained thermo-efficiency assures the lowest possible operating costs.

20,000 KW GAS TURBINE POWER PLANT

One of the largest Swiss power companies, the N.O.K., has decided to build a new thermal power station in the northeastern part of that country. The plant will supplement the winter energy obtained from existing hydro stations.

The power unit will be a 20,000 kw plant

since using Tycol turbine oils"

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Chicago • Detroit
Pittsburgh • Philadelphia
Tulsa

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

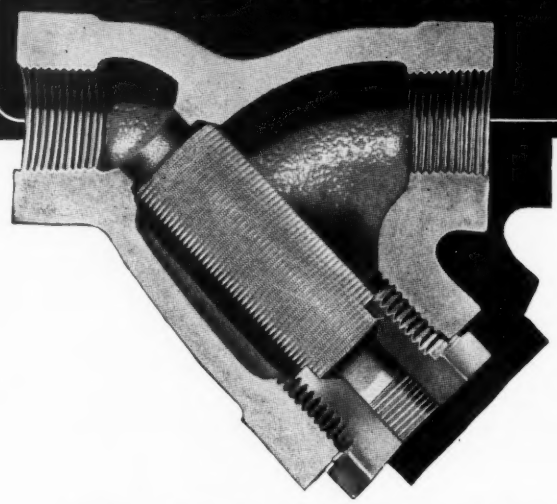
"Absolute absence of sludge . . .
Ten years without an oil change...
Bearings show no signs of wear . . .
Oil consumption cut in half . . ."

These results are typical of the excellent performances achieved with Tycol Turbine Oils. Refined by a special process, these modern lubricants stand up under the toughest service conditions . . . retain their original characteristics.

Call your nearest Tide Water Associated Office today for full information about the time- and money-saving advantages of Tycol Turbine Oils. Rust inhibited *Tycol RIO Turbine Oils* are also available for operations where corrosion may be a factor.

LUBRICATION—"ENGINEERED TO FIT THE JOB"

It says
"STOP" to Solids—
"GO" to Fluids



A BETTER Strainer to "police your pipelines"

• **FIRST**—*The Screen*, a high-grade woven Monel wire basket that catches solids—lets condensate, oil or other fluids flow freely.

• **SECOND**—*Finish*. Cadmium plated for protection against corrosion and for better appearance.

• **THIRD**—*Easily Cleaned*. Blow-off bushing made for easy removal. Bushing and Screen come out together. Screen automatically aligns on reassembly.

• THOUSANDS IN SERVICE—Sold by over 100 Mill Supply Houses.

6 sizes from ½" to 2" for pressures up to 600 lb. Reasonably priced. See your supply house or write for Bulletin S-201.

YARNALL-WARING COMPANY
114 Mermaid Ave. PHILADELPHIA 18, PA.

YARWAY STRAINERS

built by Sulzer Bros. which will operate on the special high pressure cycle developed by that firm; it will drive a 25,000 kva generator. The capacity of the station's oil tanks will correspond to a production of 60,000,000 kw hr. It is expected that the plant will be put in service during the winter of 1949-1950.

This will not be the first large gas turbine unit built by Sulzer. This company expects to have in operation, long before this 20,000 kw stationary unit, a marine gas turbine plant of around 7,000 hp which will be put into a ship after completion of shop tests.

PROPORTIONEERS' TRAILER TO VISIT NORTHERN STATES

A TRAILER, equipped with Proportioneers latest units illustrating basic applications of constant rate and flow responsive industrial proportioning, will leave Providence early in June.

While enroute to the West Coast the trailer will visit company offices in Albany, Niagara Falls, Detroit, Chicago, St. Paul, Kansas City, Omaha, Denver, Salt Lake City, and San Francisco. The trailer will be on exhibition in each of these cities and all interested engineers and industrial plant managers are invited to inspect it.

Equipment will include operating units for the application of chlorine dioxide, hypochlorite, diatomaceous earth, slurries, soda ash, alum, and other treating chemicals, for water purification. Also, high pressure proportioning pumps for injecting phosphates and colloids in the internal treatment of boiler water as well as sulphites and sulphates for oxygen removal.

After being on exhibit in San Francisco during the convention of the American Water Works Association the trailer will visit Proportioneers offices in Seattle, San Francisco, and Los Angeles, and will be on exhibit in the larger cities on the West Coast.

NEW BYRON JACKSON PLANT

COMPLETED recently and now occupied, a new plant addition of the Byron Jackson Pump Division covering approximately 8 acres on the south side of Vernon Avenue, Vernon, Calif., supplants the present buildings on Slauson Ave. in Huntington Park, occupied since 1920.

Erected at a cost of over $1,500,000 and begun in January, 1946, the new addition includes an administration building, and provides for machine shops, stock room and warehouse, shop cafeteria, service and pattern shops, truck shed, garage and maintenance, and oil and paint storage.

The plant and shop structures were designed by the firm of Taylor and Taylor, and the office building by Albert B. Gardner of Los Angeles. The C. L. Peck Co., construction firm, built the plant. Various materials were used in the construction, including reinforced concrete, steel, brick and aluminum, with the monitor type roof over the shop areas.

GEIST RE-ELECTED PRESIDENT ALLIS-CHALMERS

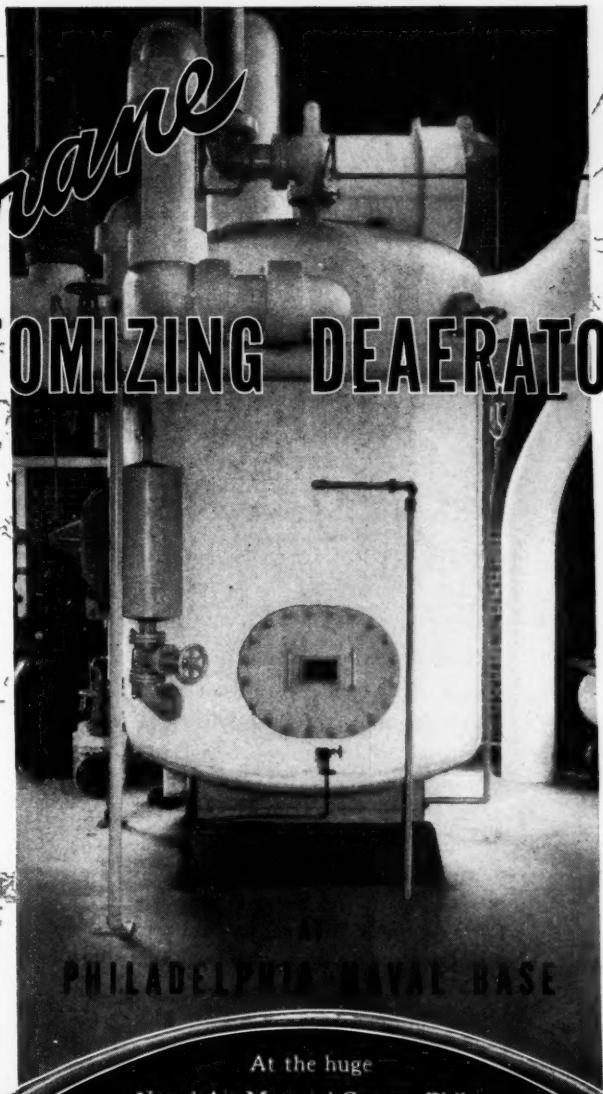
WALTER GEIST was elected for his sixth term as president of the Allis-Chalmers Manufacturing Co. recently as all directors and officers of the firm were re-elected at the annual meeting of the stockholders and the board of directors.

The directors elected by the stockholders are W. C. Buchanan, Geist, Walter Kasten, Alfred J. Kieckhefer and Louis Quarles, all of Milwaukee; Arthur W. Butler, New York, N.Y.; John H. Collier and James D. Cunningham, Chicago, Ill.; Ernst Mahler, Neenah, Wis., and Leigh Willard, Cleveland, O.

DETROIT DIESEL STARTS SCHOOL

IN RECOGNITION of the extreme importance of providing the best possible service to owners of their products, the Detroit Diesel Engine Division, General Motors Corp., has set up at its factory in Detroit a completely

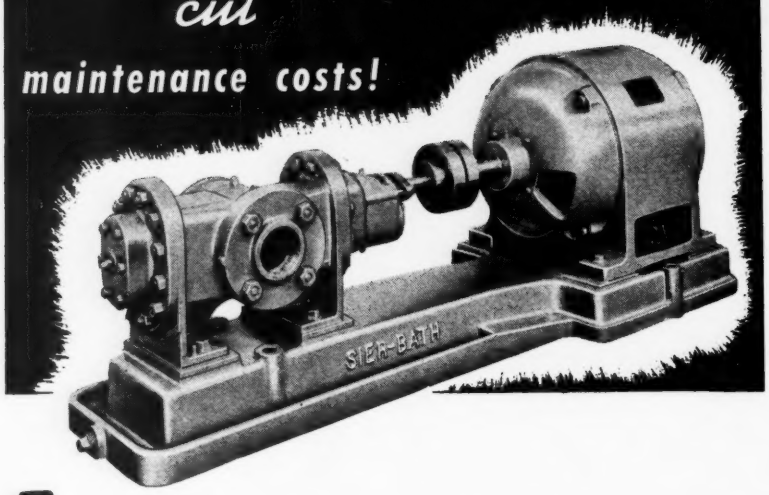
Cochrane ATOMIZING DEAERATOR



At the huge Naval Air Material Center, Philadelphia Naval Base, recent extensions to the boiler plant included a Cochrane Atomizing Deaerator of 260,000 lb/hr capacity operating under a guarantee of "zero oxygen" removal. It is especially fitting to find a Cochrane Atomizing Deaerator in a Navy boiler plant, even in a shore installation, for it was for marine use in particular that Cochrane invented the Atomizing Deaerator. While it has special advantages for stationary power plants, its great value on shipboard is its freedom from trays, permitting complete deaeration, regardless of list, pitch or roll. Light weight and compact design are other Cochrane features.

COCHRANE CORPORATION • 17th Street & Allegheny Avenue • PHILADELPHIA 32, PA.

SCREW PUMPS built to SIER-BATH accuracy *cut* maintenance costs!



The high quality of design and construction of Sier-Bath Screw Pumps enables them to operate continuously for long periods without maintenance. The pulseless flow and vibrationless operation of these pumps greatly reduce maintenance cost—there is less wear on valves, couplings and other fittings. Pipes and joints remain tight and require little attention. With maintenance labor costs at an all-time high, these are important points to consider today in the selection of pumps.

Made in an up-to-date machine shop, accustomed to precision methods and equipped with the most modern machinery, Sier-Bath Screw Pumps always measure up to the highest standards required by users. They are made in both horizontal and vertical models.

Sier-Bath customers are protected from mis-application by the mature pump engineering experience of this Company's staff. Send for descriptive booklet.

ADVANTAGES:
● pulseless flow ● anti-friction bearings ● vibrationless operation
● low maintenance cost ● rugged construction

PUMPS: Acetate, asphalts, brines, Bunker C Fuel Oil, Cellulosics, Greases, Molasses, Syrups, Lube Oils, etc.

FOUNDED 1905 MEMBER A.G.M.A.

★ ALSO MAKERS OF SIER-BATH PRECISION GEARS

Sier-Bath GEAR and PUMP CO., Inc.

9256 HUDSON BLVD. NORTH BERGEN, N. J.

equipped school for training GM Diesel mechanics in the operation and servicing of the Series 71 engine. Detroit Diesel distributors and dealers may, upon proper application, send their service personnel to the factory for a concentrated but thorough training course in basic Diesel mechanics.

This course has been specifically designed to develop skill in the maintenance and repair of Series 71 engines and to create an understanding of operating requirements and trouble shooting procedure. Classes of twelve students are scheduled every two weeks depending upon the number of applications received for the course. By limiting the enrollment to small numbers, each student is guaranteed personalized instruction through the entire training period.

FARRIS ENGINEERING APPOINTS SALES MANAGER

V. M. Farris, President of the Farris Engineering Corp., Palisades Park, N.J., has announced the appointment of Paul Robinet as Sales Manager.

Mr. Robinet, a Mechanical Engineering graduate of the University of Southern California brings with him a background of wide experience in the Safety and Relief Valve field, having been for eight years the West Coast Sales Engineer, particularly in the Oil, Steam and Maritime Industries, for Consolidate-Ashcroft-Hancock division of Maxwell, Manning and Moore, Inc. Two years ago, he was made Sales Engineer in their New York office, which position he has recently resigned.

With Farris Corp., he will be in charge of formulating sales and promotional policies throughout the United States for this rapidly expanding organization.

CORNING GLASS FORMS EASTERN SALES DISTRICT

Formation of an Eastern Sales District for the Technical Products Division of Corning Glass Works was announced recently by the company.

The purpose behind the organization of the new district, with main offices in New York City, is to bring the company sales representative closer to Corning's customers.

The new district—second in the division's national sales organization—will be staffed initially by six sales representatives. Charles L. Day will manage the new sales district. Originally associated with Corning Glass Works in 1936 as a sales engineer, Mr. Day joined Owens-Corning Fiberglas Corp. at the time of its formation in 1938.

MINTON TO MANAGE KOPPERS' PRODUCTION

Brig. Gen. Hugh C. Minton, who was awarded the Distinguished Service Medal for his "able direction" of the Army Service Forces' Production Division during World War II, will become Production Manager of Koppers Co., Inc., it was annouonced recently.

In his new position, General Minton will report directly to General Brehon Somervell, President of Koppers, thereby re-establishing in civilian life a relationship set up in wartime when General Somervell was Commanding General of the Army Service Forces.

General Minton's new assignment in Pittsburgh brings him back to the city where he served during nearly five years of his Army career. He was executive assistant to the Chief of the Pittsburgh District from August 1935 to July 1938, and returned to Pittsburgh as Chief of that Ordnance District from July to November, 1942.

Manhattan Rubber Division of Raybestos-Manhattan, Inc., Passaic, New Jersey, has announced that Asbestos Co. of California, 941 Sixteenth Street, San Francisco, will represent it in the San Francisco area. The Asbestos Co. will carry a complete stock of belting, V-belts, hose of all types and other industrial rubber products. Their customers will also have the advantage of proximity of the new Raybestos-Manhattan warehouse in San Francisco.

Bailey Meter Co., Cleveland, Ohio, has announced the appointment of Portilla Corp.

First Steps . . .

MARK DISCOVERY Like an explorer hacking his way into unknown lands, the early Dearborn chemist penetrated the realm of research. His objective . . . to track troublesome water characteristics to their source; to end scale deposits, foam, and corrosion difficulties.

Analysis of a sample of scale deposit was the first step. The water analysis and treatment formulation followed. Water troubles could then be prevented by scientific analysis and chemical treatment.

Subsequent Steps

ACHIEVEMENT New discoveries stir the pulse and imagination. Time verifies their merit. Today, marking our 60th Anniversary, Dearborn Water Treatment and Service are a vast enterprise . . . devoted to the prevention of water troubles the world over. Footsteps can be far reaching . . . they can lead, as they do here, to clean steam . . . long, trouble-free boiler life for industry . . . everywhere.

Dearborn Service Today!

OFFERS YOU THE ULTIMATE IN BOILER WATER TREATMENT

ESTABLISHED IN '97

EXPLORING NEW HORIZONS IN '57

Dearborn

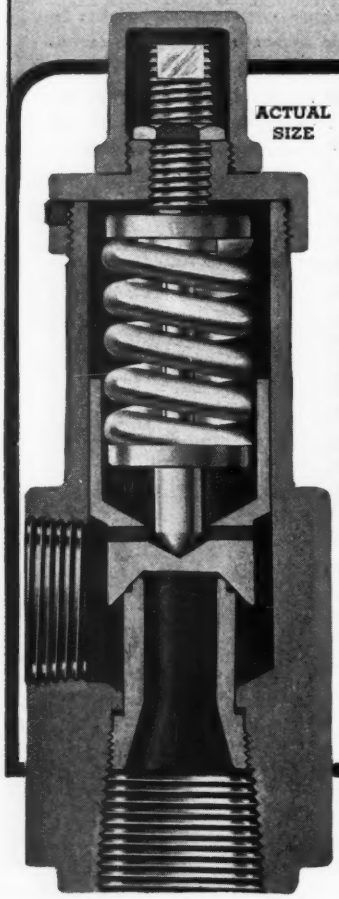
TRADE MARK REGISTERED

"THE LEADER FOR 60 YEARS"
ENGINEERING SERVICE AND WATER TREATMENT

Dearborn Chemical Company
Dept. F, 310 S. Michigan Ave., Chicago 4, Ill.
New York • Los Angeles • Toronto

HIGH CAPACITY
LOW COST
SMALL NOZZLE–RELIEF VALVES

For Pressures to 10,000 psi.
Available from Stock
IN STAINLESS STEEL, STEEL AND BRASS

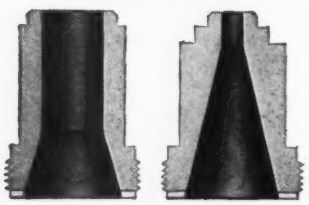


ACTUAL SIZE

A Tight Relief Valve!

- **Top-guided disc-piston with two-point bearing surface always assures perfect seating, smooth action and definite operation at the set pressure.**
- **Certified full capacity achieved by high disc lift developed by utilizing the full force of the nozzle flow. Result: Smaller body size required for given capacity.**
- **Nozzle seat well above the drain line prevents accumulation of scale or sediment and assures full free opening.**
- **All parts are machined from forged bar stock . . . brass, cold-rolled or stainless steel . . . which permits compact design with sound metal in all parts. All nozzles and discs are of stainless steel.**

Investigate the savings possible with the Type 2745 Valve. Further detailed data is available on request . . . without obligation.



2 NOZZLE SIZES FOR EACH BODY SIZE.

DIMENSIONS

Size in.	Nozzle Area sq. in.	Max. Pres. psi.	Overall Height in.
½	0.077 0.019	2000 10000	5¼
¾	0.077 0.019	2000 10000	5¼
1	0.250 0.045	2000 10000	6⅞

FARRIS ENGINEERING CORP.
400 Commercial Ave., Palisades Park, N. J.

Farris

SAFETY and RELIEF VALVES

FARRIS keeps pace with advancing power and process engineering

1005

as its agent in Puerto Rico. This corporation has taken over the business formerly conducted by H. Clyde Gregory, Inc. It will act as the agency for the sales, installation and servicing of Bailey equipment in Pureto Rico, Republic of Haiti, Dominican Republic and the Virgin Islands.

Ampco Metal, Inc., Milwaukee, Wis., has announced the appointment of The John C. Fitzpatrick Co., Toronto 1, Ontario, as sales agent in the Province of Ontario.

Announcement has been made by the Snap-on Tools Corp., Kenosha, Wis. of the opening of the company's 40th factory outlet at 421 N.P. Avenue, Fargo, N.D. Snap-on announced that Louis J. Johann, formerly a fieldman with the Minneapolis branch, will manage the Fargo office. This latest addition to Snap-on's sales organization will concentrate on servicing the rapidly expanding Dakota industrial scene.

The Bird-Archer Co., specialist in industrial water treatment, has just appointed the John H. Carter Co., New Orleans, as its representative in Louisiana, southern Arkansas, eastern Texas and southern Mississippi.

In line with its new policy of speedier service to its customers, the Pennsylvania Flexible Metallic Tubing Co. of Philadelphia is increasing its facilities in the midwestern industrial territory. On May 1st, the company will open a warehouse and sales office at 4352 W. Harrison Street, Chicago.

MANUFACTURERS' *Personals*

A. P. GREEN REORGANIZES MANAGEMENT CONTROL

THE A. P. GREEN Fire Brick Co., with general offices and plant at Mexico, Missouri, announce the reorganization of management control into six major divisions. (1) Sales; (2) Affiliate & Subsidiary Companies; (3) Manufacturing; (4) Procurement & Properties; (5) Finance and (6) Industrial Relations.

Herbert B. Plunkett becomes Director of Sales which includes both domestic and export operations; Arthur D. Bond will be Director of Affiliate and Subsidiary Companies both domestic and foreign; Lester J. Miller becomes Director of Manufacturing; Neal S. Wood will be Director of Procurement and Properties; D. H. Kreutzer, Director of Finance, and Walter G. Staley, Director of Industrial Relations. All six men in this new alignment of A. P. Green organization functions are Vice-Presidents and members of the company Board of Directors.

BRIGGS HEADS PRODUCTION AT MARLEY CO.

CHARLES B. BRIGGS, JR. has been appointed Production Manager of the Kansas City, Kansas plant of The Marley Co., Inc.

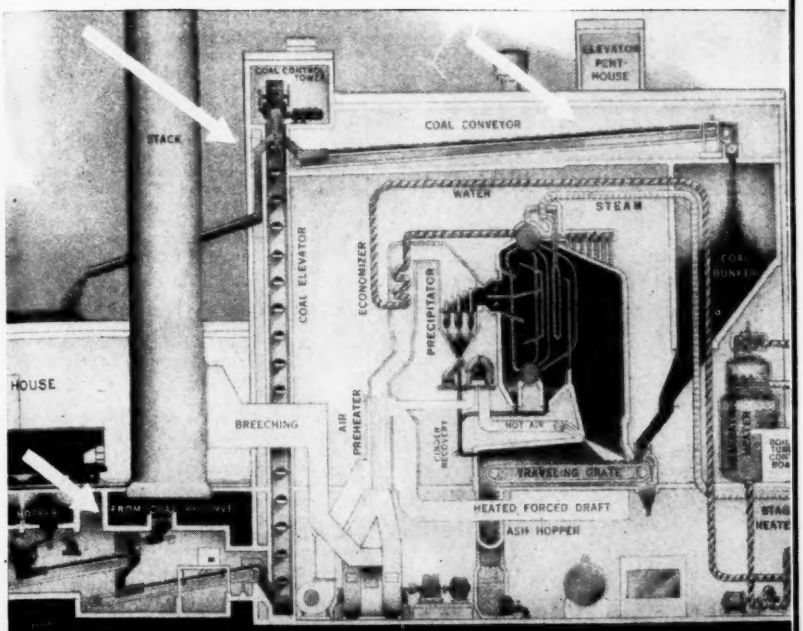
Mr. Briggs, who has been with The Marley Co. since September, 1944, as application engineer and Public Relations Director, succeeds E. A. Ostrom who is now manager of the Marley Stockton plant.

Briggs received his B.S. degree in Mechanical Engineering from the University of Missouri. He also did graduate work at the University of Missouri, the University of Kansas and Kansas City University.

Before joining The Marley Co., Briggs served in the Production and Manufacturing Departments at United Aircraft Corp. at East Hartford, Conn., as as a Construction and Operation engineer with the United Light and Railway chain in Kansas City.

Appointments of Floyd M. Shumway and R. S. Oschner as North Central district representatives of General Electric's accessory

CUTTING COSTS WITH CONVEYORS •



Conveyor-elevator system solves unusual problem at central station

● Here's the perfect "doubles" team for power plant materials handling: Link-Belt experience in designing thousands of handling systems for highest efficiency . . . and Link-Belt standard-unit equipment for low first cost and minimum maintenance.

At the Jennison steam-electric generating station of the New York State Electric & Gas Corp., Bainbridge, N. Y. (Gilbert Associates, Inc., Consulting Engineers), the problem was that of handling an abrasive type of coal (No. 4 washed buckwheat anthracite) automatically from R. R. cars to overhead bunkers or reserve, or from reserve to bunkers—at 100 tons per hour.

As shown in illustration above, the integrated Link-Belt handling equipment consists of: 4 reciprocating feeders under track hopper openings, delivering to No. 1 belt conveyor. No. 2 belt conveyor receives coal from No. 1 belt conveyor or reserve storage. A vertical bucket elevator with two-way chute discharges to storage or to No. 3 belt conveyor, as needed. The No. 3 unit discharges to a screw conveyor that takes the coal to the bunkers.

Would you like to have more details on this and other installations? Get in touch with our nearest office.

LINK-BELT COMPANY 10,616

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

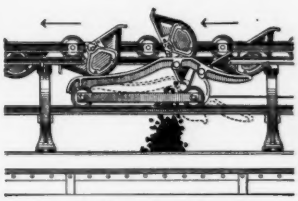
LINK-BELT

THE SYMBOL OF QUALITY — LB — LINK-BELT

COAL AND ASHES HANDLING EQUIPMENT

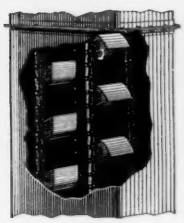
LINK-BELT EQUIPMENT

Meets Every Need of Industry in Handling Materials



Bucket Carriers

Belt Conveyors



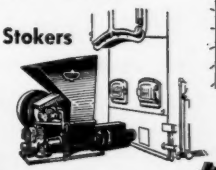
Bucket Elevators

Bulk-Flo

Screw Conveyor

Skip Hoist

Coal Crusher



Stokers

Car Dumper

Weigh Larry

DARTS
CLOSE EASILY
WITHOUT JAMMED-JOINT DAMAGE

Because their two bronze seats are ground to a true ball joint

Since the two non-corroding bronze seats are precision-ground to form true bearing surfaces, Darts close easily . . . without excessive wrench pressure . . . without jammed-joint damage . . . to a drop-tight connection. When needed in another location, they uncouple easily and may be used economically again and again. Body and nut are made of high-test, air-refined malleable iron and are practically indestructible. Your supplier will be glad to give you the whole story on Dart's unique construction.

E. M. Dart Mfg. Co., Providence 5, R. I.

DART UNIONS

equipment products, and tungar and metallic rectifiers respectively have been announced.

Leroy F. Marek has been elected Vice-President of Arthur D. Little, Inc., Cambridge, Mass., industrial research organization, by the Board of Directors of that company. Mr. Marek has been with Arthur D. Little, Inc., since 1934 and has for several years been in charge of its chemical engineering activities. He is a graduate of the University of Texas and received his master's degree from Massachusetts Institute of Technology, where he served as Acting Director of the Research Laboratory of Applied Chemistry before joining Arthur D. Little, Inc. Mr. Marek is a resident of Lexington, Mass.

F. Q. Wilson, has been appointed Elliott Co. Cincinnati district manager. Mr. Wilson, an electrical engineer graduate of Tulsa office in 1942, became Tulsa manager in 1945.

J. I. Onarheim has joined the staff of the central station and marine sales department of the Allis-Chalmers Mfg. Co., according to a recent announcement. In his new post, Mr. Onarheim, who has had more than 20 years of design and sales engineering experience in the company's electrical department, will assist both the product departments and the district offices in the promotion and coordination of sales activities with utilities and municipalities. For the last seven years he served as the company's employment manager.

W. M. Hicks, 41 Park Row, New York City, has been appointed sales representative by Gibson Electric Co., Pittsburgh, Pa. His territory will cover the New York Metropolitan area, including Northern New Jersey.

Walter P. Berg has been elected vice president and member of the board of directors of Dravo Corp., Pittsburgh, Penn. A graduate of Lehigh University (M.E. degree, 1917), Mr. Berg came to Dravo in 1923 as an assistant engineer. He was active in engineering and sales work until 1938 when he became manager of the Power Department of the corporation's Machinery Division. In 1946 Mr. Berg was appointed general manager of the Machinery Division of Dravo Corp., in which capacity he continues in addition to his new duties.

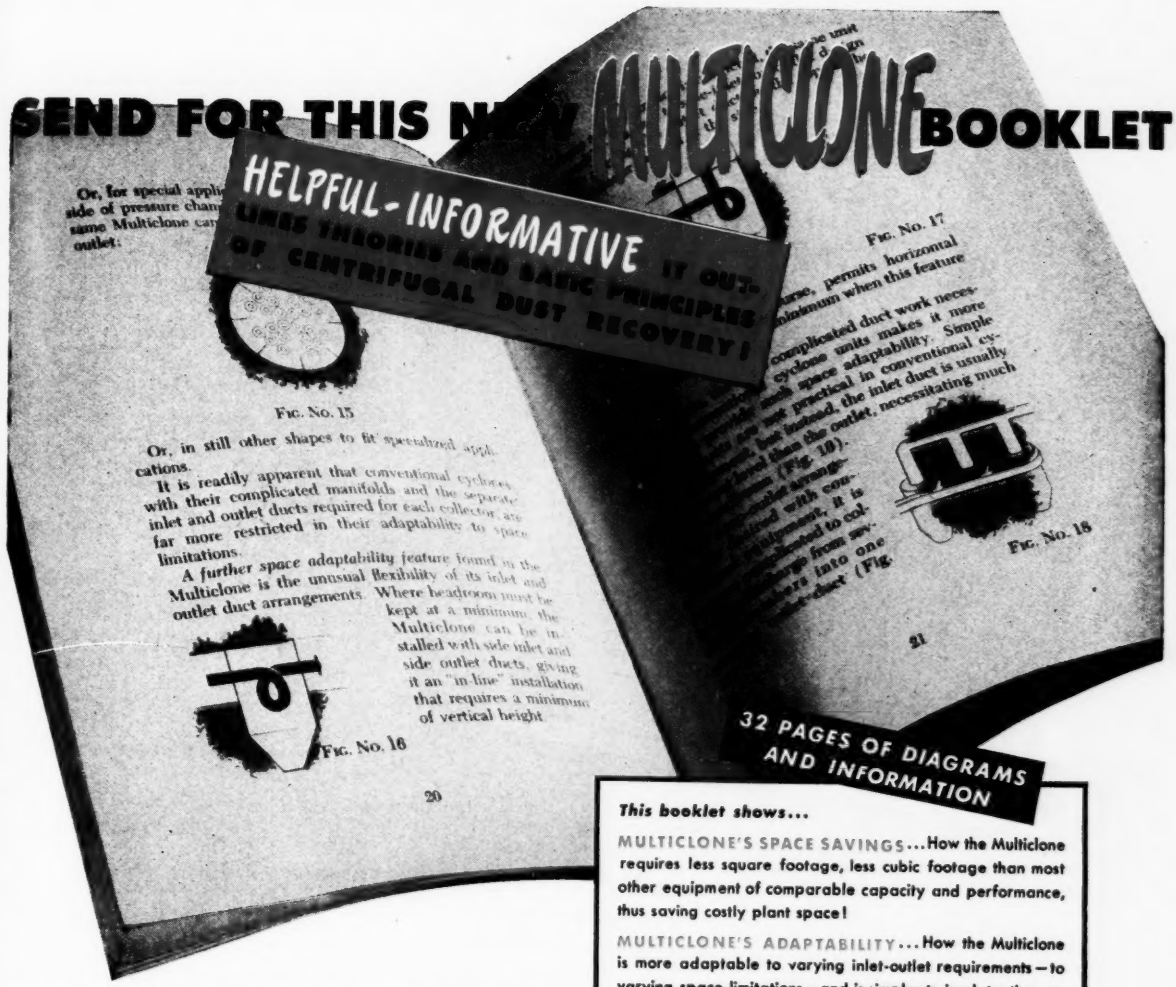
L. A. Hamilton, formerly assistant manager of Air Reduction's Seattle District has been appointed manager of that district, E. W. MacCorkle, Jr. has been appointed the company's Portland district manager and Herman Van Fleet, Jr. has been appointed manager of Air Reduction's New England District according to recent announcement.

R. H. Kutscher has recently been appointed manager for the Pittsburgh sales territory of Electric Machinery Mfg. Co. He succeeds H. L. Renking, who becomes District Manager of the Southwestern Territory with headquarters at Dallas, Texas.

Frank E. Gerlitz, Jr. has been appointed Sales Manager of the Simplex Valve & Meter Co. of Philadelphia, Pa. He first went with the company in 1941, serving in the capacity of Sales Consulting Engineer, and in 1946 was made Assistant Sales Manager. Prior to his connection with the company he obtained wide experience as a designing engineer in muncipal water and sewage treatment plants and further added to his experience in this field by his association for several years with the Pennsylvania State Board of Health.

C. C. Chamberlain, general sales manager of Jenkins Bros., has been elected a vice president of the company, according to announcement by Alfred J. Yardley, president. Mr. Chamberlain joined the company in 1929 on graduation from Hamilton College. Starting as an assistant in the advertising department, he was appointed advertising manager in 1932, and advanced to publicity manager

SEND FOR THIS NEW MULTICLONE BOOKLET


HELPFUL-INFORMATIVE
LIMES THEORIES AND BASIC PRINCIPLES OF CENTRIFUGAL DUST RECOVERY!
IT OUT-
Fig. No. 15
Or, in still other shapes to fit specialized appli-
cations.
It is readily apparent that conventional cyclones,
with their complicated manifolds and the separate
inlet and outlet ducts required for each collector, are
far more restricted in their adaptability to space
limitations.
A further space adaptability feature found in the
Multiclone is the unusual flexibility of its inlet and
outlet duct arrangements. Where headroom must be
kept at a minimum, the
Multiclone can be in-
stalled with side inlet and
side outlet ducts, giving
it an "in-line" installation
that requires a minimum
of vertical height.
Fig. No. 16
20
Fig. No. 17
Fig. No. 18
21
32 PAGES OF DIAGRAMS AND INFORMATION

NO MATTER whether you are now using mechanical dust recovery equipment or are planning the installation of such equipment at some future date, here is a booklet just published that is full of helpful and valuable information on centrifugal dust recovery. It not only explains the basic methods and principles involved, but also shows the important differences between small and large diameter separating tubes, shows how to simplify your duct work and reduce installation costs, and outlines many other important factors to be considered in selecting mechanical dust recovery equipment.

In addition, this informative booklet illustrates and explains how MULTICLONE'S unique *vane* design is fundamentally different... how it makes possible greater compactness, simpler installation, high recovery of the small particles as well as the medium and coarser ones, and many other facts on MULTICLONE advanced design.

A limited supply of these booklets is available for free distribution to those interested in mechanical recovery equipment and methods. Write for your copy today.

This booklet shows...

MULTICLONE'S SPACE SAVINGS... How the Multiclone requires less square footage, less cubic footage than most other equipment of comparable capacity and performance, thus saving costly plant space!

MULTICLONE'S ADAPTABILITY... How the Multiclone is more adaptable to varying inlet-outlet requirements—to varying space limitations—and is simpler to insulate, thus reducing installation costs!

MULTICLONE'S EFFICIENCY... How Multiclone's multiple *small diameter* tubes, made possible by its exclusive vane design, give higher centrifugal forces and more complete cleansing of *all* suspended particles—even small ones of 10 microns and less!

MULTICLONE'S LOW MAINTENANCE... How the Multiclone has no high speed moving parts to repair or replace, no pads or filters to clean or renew, nothing to choke gas flow or increase draft losses as suspended materials are recovered. Multiclone draft losses remain uniformly low—recovery efficiencies uniformly high—at all times!

Make sure that a copy of this new booklet is in your reference files by sending for your copy now!

NOW SELLING...

COTTRELL Precipitators
MULTICLONE Collectors
TURBULAIRE Spray Dryers

...in all parts of the U.S.A. and foreign countries.

WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

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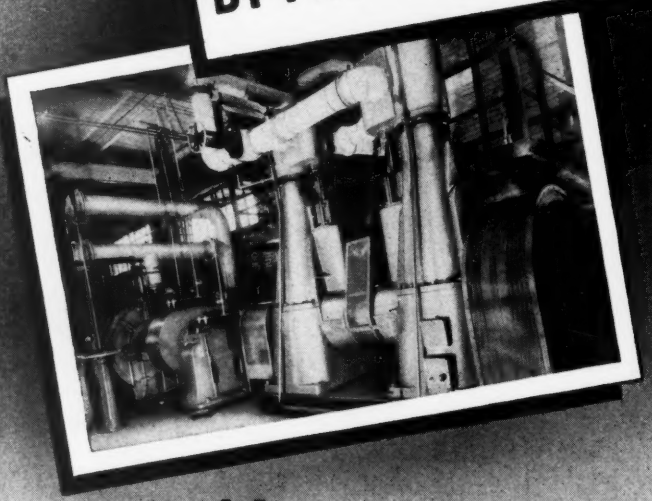
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

TROY-ENGBERG
STEAM ENGINE

SAVE
BY USING
BY-PRODUCT POWER



Make your STEAM do two big jobs . . . eventually one of them at little or no cost. With proper heat balance your steam can provide—FIRST, power for driving equipment, and SECOND, heat units needed for processing or heating.

Use boiler steam to run a Troy-Engberg Steam Engine. THEN use the exhaust in your heating or processing lines. Drive your pumps, stokers, generators, blowers or compressors with By-Product Power. Use a Troy-Engberg Steam Engine as a reducing valve and your power cost saving will pay for the engine in a very short time.

Send for Bulletin 306

TROY ENGINE & MACHINE COMPANY
Established 1870
800 Railroad Avenue Troy, Pennsylvania

TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

in 1940. He was named general sales manager in 1942. Mr. Chamberlain recently was elected to the board of directors of the company.

Daniel B. Benscoter, Cincinnati has been appointed District Sales Engineer for the Machinery Division of Dravo Corp., Pittsburgh. Mr. Benscoter's office will be in the Southern Ohio Bank Building, Cincinnati. His district, covering Kentucky and southern Ohio and Indiana, is part of Dravo's Cleveland Region.

Liquid Conditioning Corp., Linden, N.J., announces the appointment of William A. Krebs as engineering and sales representative in the district including Philadelphia, the counties in Pennsylvania close to Philadelphia, Southern New Jersey, and the state of Delaware. Mr. Krebs has had extensive experience as service engineer in the problems of water treatment for power stations and industrial plants in this territory, and is a member of the National Association of Power Engineers. His headquarters are at 1424 Land Title Building, Philadelphia 10, Pa.

Roy W. Maze has been appointed Public Relations Director of The Marley Co., Inc. Mr. Maze entered the Marley Co. in November, 1946 and succeeds Charles B. Briggs, Jr. who is now Production Manager of the Kansas City, Kansas plant.

The appointment of George W. Hopkins, Jr., as Great Lakes district representative for General Electric wiring devices has been announced. Mr. Hopkins came with the company in 1945 as an order service clerk in the accessory equipment and wiring device divisions in Bridgeport, Conn. Last year he became a sales clerk in wiring device sales.

John B. Ives has been appointed Manager of Operations of Laclede-Christy Clay Products Co. He reports directly to the General Manager. In this capacity Mr. Ives will have complete charge of the manufacturing and mining operations of our St. Louis and Toledo plants and mines.

Peabody Engineering Corp. has appointed W. L. Byler, Advertising Manager. For the past three years he has been with Peabody Engineering Corp. in Engineering and Production work, where he also functioned as liaison man between phases of production and advertising, gradually assuming more responsibility for the Advertising Department. Prior to his association with Peabody Engineering Corp., Mr. Byler was a district sales representative and trained distribution salesmen to handle power transmission equipment. Before that he was a Safety Engineer.

Liquid Conditioning Corp., Linden, N.J., announces that Vincent J. Calise has joined its organization in the capacity of Technical Manager. Mr. Calise has long been associated with the development and production of ion exchange materials and the practical application of such materials in zeolite water softeners and other types of cation and anion exchange equipment.

Dave S. Ferree was recently appointed District Manager of the new Philadelphia sales office of The Falk Corp. His territory includes the Pennsylvania and Delaware areas formerly handled by Martell and Ferree and the York, Pennsylvania area, which was managed by the late John Ericson.

Election of Malcolm W. Reed as engineering vice-president of Carnegie-Illinois Steel Corp. was announced recently. Mr. Reed has been chiek engineer of the company since March 1, 1939. Previously he was vice-president in charge of operations of the American Steel and Wire company, another U. S. Steel subsidiary.

Ladish Co., Cudahy, Wisconsin announces the appointment of H. L. Pehrson as manager of West Coast Sales of Ladish Controlled Quality Forged and Seamless Welding Pipe Fittings with offices at 714 West Olympic Boulevard, Los Angeles 15, Calif.

This Screen and Filter Cloth does the Job for less!

How many times have you wished you could eliminate the shortcomings of ordinary fabric or metal cloth by using filters and screens made of Monel*, Nickel, or Inconel*.

Maybe you've thought they were too expensive to use in your equipment.

Far from it!

In many weaves, this cloth is *cheaper* than less durable metal. The low initial cost and longer service life actually can save you money.

Speak to your equipment manufacturer. Tell him you want the extra protection of the "task metals" in your filters and screens.

All weaves and meshes are available from regular wire weavers.

*Reg. U. S. Pat. Off.

Send for our booklet: "Established Weavers of Monel, Nickel and Inconel Wire and Filter Cloth."

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

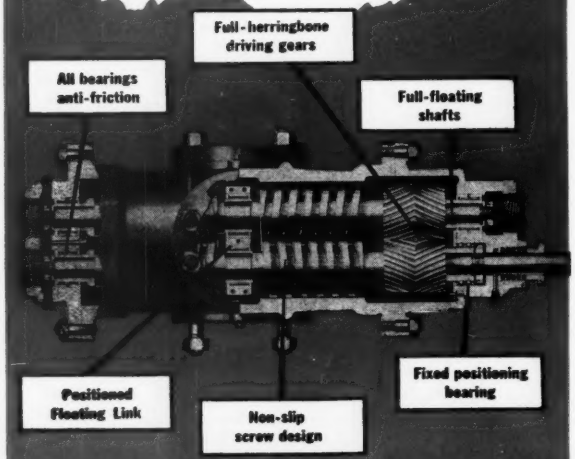
INCO TRADE MARK

Monel* Nickel Inconel*

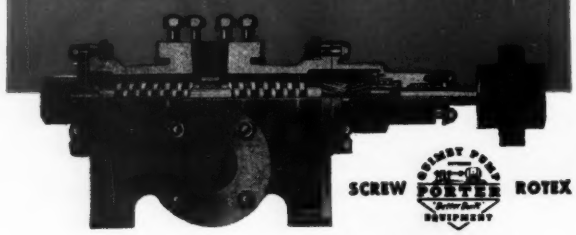
"TASK METALS" FOR INDUSTRY

QUIMBY
THE ORIGINAL
SCREW PUMP

Only in a Quimby do you get all these essential features



Plus—A CHOICE OF 134 TYPES IN A COMPLETE RANGE OF SIZES



SCREW — ROTEX — CENTRIFUGAL

When you buy a QUIMBY you get a pump made by a *pump manufacturer* backed by 53 years experience in designing and building pumps. Write for Bulletin S-204.

Remember, there is no substitute for a Quimby!

Quimby Pump Division
H. K. PORTER COMPANY, Inc.
PITTSBURGH 22, PENNSYLVANIA
District Offices in Principal Cities

ENGINEERS' PREVIEW

(Continued from page 7)

★ ★ ★

SINCE GLYCERINE does not mix with most organic solvents, it can be included in a special filler for making wooden containers impervious to organic liquids, especially gasoline. This filler developed by T. M. Finley is described in U. S. Patent 2,410,654. Wooden containers are hot-impregnated with a soap composition containing 21 parts of glycerine. This is followed by carefully cleaning and painting the interior surfaces with three coats of flat synthetic enamel.

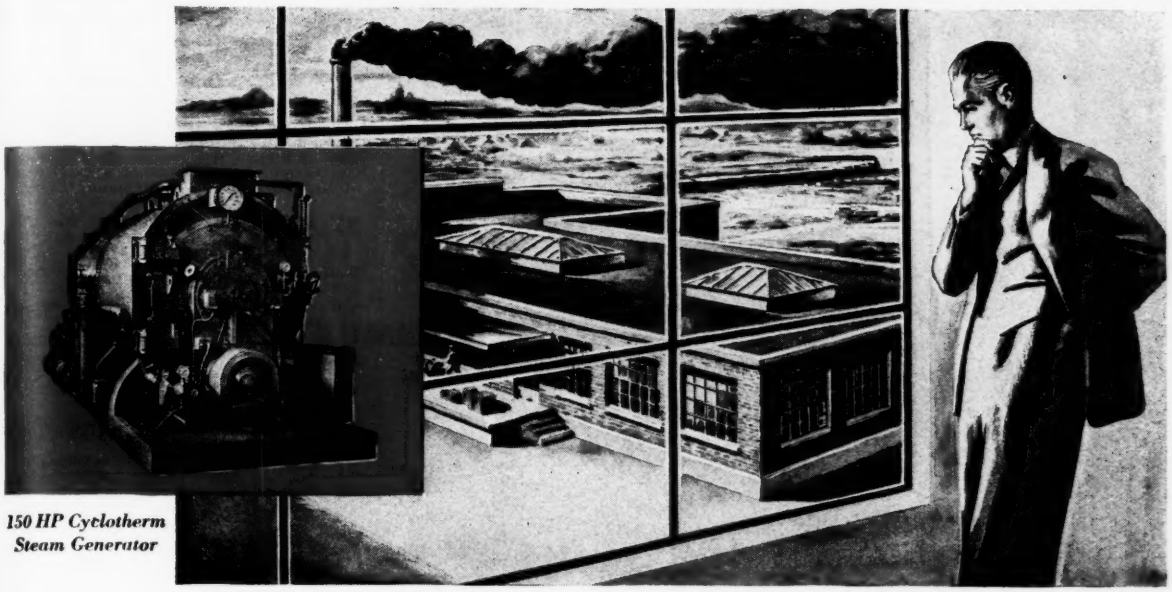
★ ★ ★

NATURE CARRIES ON an unrelenting attack by means of soil corrosion on our buried pipe lines, power and communication cables, rail systems and other metal structures. The destruction thus caused is needless said H. H. Anderson, Vice President of Shell Pipe Line Corp. in a paper recently presented before the National Association of Corrosion Engineers, because much of the damage can be stopped by cathodic protection. Cathodic protection is nowadays deemed so important that eight industry associations, the two nation-wide communications companies and a professional association recently joined their efforts in a committee to inform industrial managers about it, to promote co-operation within and between industries and in applying it, and to aid the local solution of its technical problems. According to Bureau of Standards Circular C-450, the annual cost of pipe line replacements due to corrosion is approximately $200,000,000 a year. This does not take into account the costs of replacing various other types of plant suffering from soil corrosion. Details about the cathodic protection method of preventing corrosion were given in "How Cathodic Protection Prevents Pipe and Tank Corrosion," POWER PLANT ENGINEERING, June 1946, page 83. Mr. Anderson's paper entitled, "Our Billion-Dollar Side-Show," is addressed specifically to managers, contains no mathematics, is written in a sprightly, humorous, persuasive manner. Engineers will do well to call it to the attention of non-technical executives in their industries, who should be made fully aware that cathodic protection may be of great use to them. The inter-industry committee on correlating cathodic protection is made up of representatives from the Association of American Railroads, American Gas Association, American Petroleum Institute, American Public Works Association, American Water Works Association, Bell System, Edison Electric Institute, International Municipal Signal Association, Inc., National Association of Corrosion Engineers, United States Independent Telephone Association and Western Union Telegraph Co. Chairman of the Committee is H. H. Anderson, Vice President, Shell Pipe Line Corp., Shell Building, Houston 2, Texas, and Secretary is F. E. Dolson, Engineer, St. Louis County Water Co.

★ ★ ★

DYNAMITE in a research laboratory sounds paradoxical; nevertheless, steel plant laboratories use it to explode steel ingots for examination.

—The Ohmite News



150 HP Cyclotherm Steam Generator

Are you Beating Competition in cost of steam—*if not*

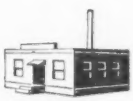
WRITE CYCLOTHERM

Flexibility in operating a single Cyclotherm, or a battery of several, meets all demands for maximum or minimum production of steam economically without impairment of operating efficiency.

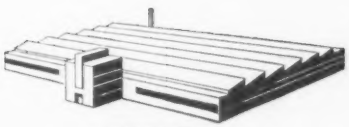
The automatic modulating steam pressure control system of a Cyclotherm Steam Generator provides the proper quantitive fuel-air relationship for all firing rates, but with oil (or gas) and air pressures constant.

Such soundly economical efficiency accounts for the steadily increasing purchases of Cyclotherms by both large and small producers of steam for processing, power and heating. These customers did not buy Cyclotherms with their eyes shut. They knew that the efficient production of steam is a profit-building factor in all competitive business fields.

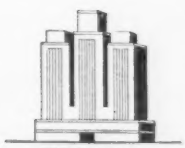
If you have a problem based on reducing operating or maintenance costs in steam production, write or telephone us. Your inquiry will receive our immediate attention.



POWER



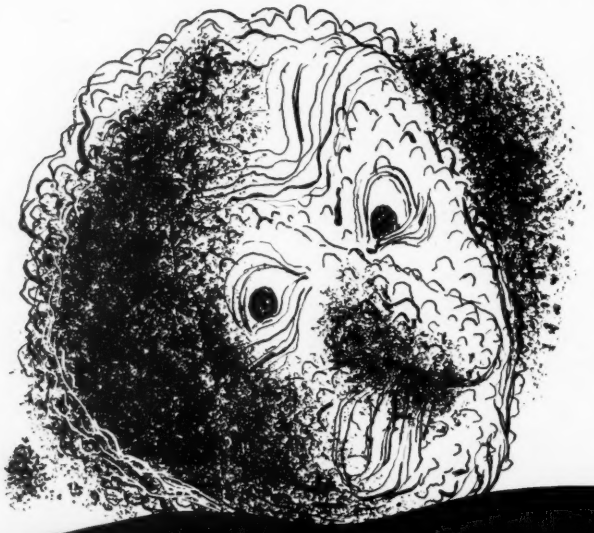
PROCESSING



HEATING

CYCLOTHERM STEAM GENERATORS

CYCLOTHERM CORPORATION, 90 BROAD STREET, BOX 117Z, NEW YORK 4, N. Y.



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by using De-ionized Water for your boiler feed

ILLCO-WAY Alkalinity is readily and accurately controlled when you use ILLCO-WAY De-ionizers to treat boiler feed water. Maintenance of satisfactorily high pH and total removal of corrosive gases assure years of trouble-free boiler operation.

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Boiler Feed-Water Treatment

Complete equipment for Chemical Processing: Purification of industrial wastes, Separation of Chemical Solutions, Purification of Chemical Solutions, Reclamation of Valuable Constituents

HELPFUL BULLETINS

(Continued from page 32)

to estimate the proper size heater are given. Excellent tables of approximate conditions under normal operation are presented and several line drawings present data on single and three-phase installation. Photographs of typical installations and pictures of special sizes of heaters appear. Electromode Corp.

37 Direct-Fired Heaters—Bulletin 801-A, 4 pages, contains a considerable amount of information on gas or oil fired heaters in floor models and horizontal and inverted suspension models. Construction and operating advantages of many of the parts of the units are described in detail and a complete table of ratings for nine sizes of heater are given. Another table, accompanied by drawings, lists the dimensions. Airtherm Mfg. Co.

DRIVES, COUPLINGS

38 Flexible Couplings Bulletin—There are four pages in this bulletin which describes the company's Series A flexible coupling. A cut-away wash drawing of the coupling shows some of the unit's construction features. Engineering information includes tables and drawings of dimensions, a table of standard gear coupling ratings, listing of service factors. John Waldron Corp.

39 Motoreducers Handbook—There are 64 pages in Buletin 3100, printed in three colors, and they cover a huge amount of engineering and catalog information on this company's standard drives for all requirements. Sectional blueprint drawings of the units, complete descriptions comprise the fore part of the bulletin. "Method of Selection," and "How to Select," precede many tables of selection data on three classes of drives. Falk Corp.

40 Flexible Joints Bulletins—Bulletins 164, 165 and 167 are small folders, just issued, describing this company's line of flexible joints. Illustrations show the joints installed in many places wherever a flexible or swing pipe joint is required. They are designed to convey compressed air, steam, water, gas and other fluids under high or low pressure. Tables and drawings of dimensions of various types are given. Flexo Supply Co.

41 Catalog on Gears—Double helical gears are described in Bulletin 1958-A; the Bulletin points out how it is often advantageous to use gears in order to secure the highest economy of operation of both turbine and driven machines. Specifications of the company's gearing is described and in this section is covered the gear case, bearings, lubrication. Applications of the unit for reducing and increasing speed also are covered. Several pages of photographs of geared turbo units installed in various plants are given. The back portion of the catalog covers outline dimensions—tables of dimensions accompanied by drawings. Moore Steam Turbine Div., Worthington Pump and Machinery Corp.

PIPING

42 Piping System Color Codes—"Color Identification of Piping Systems," is the title of a recently-issued 8-page bulletin; this bulletin is accompanied by a four-page folder with a condensed table of color identification and actual color samples of the company's enamel. The first part of the large bulletin covers the reasons for a color code, tells about various codes. A full-page table gives classification of materials carried in pipes. Object and Scope, Definitions, Method of Identification, Main Classification by Color, Detailed Instructions for Working Out a Standard Identification Scheme and Identification Markings are other sections in the bulletin. American-Marietta Co.

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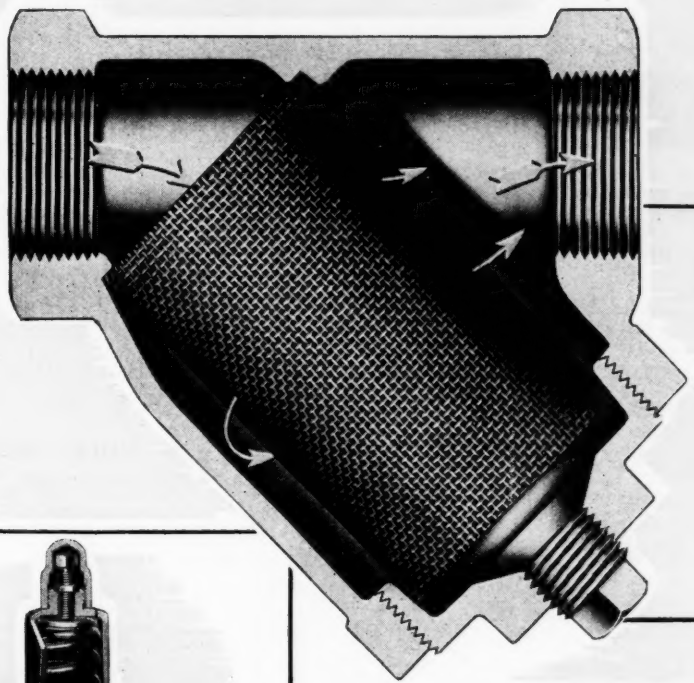
for those who seek LOW-COST Protection

FOR INSTRUMENTS...REGULATORS and VALVES



McAlear No. M-530
SELF CLEANING
Y-TYPE STRAINER

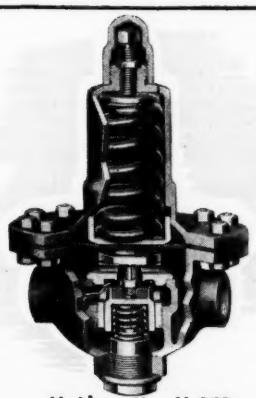
Cast Steel with Monel Metal Basket

SIZES:
Screwed end—½" to 2" inclusive
Flanged end—1½" to 8" inclusive

PRESSURES:
Up to 600 lbs.

• Installed ahead of instruments, regulators, etc., McAlear No. M-530 Strainer positively removes all grit, pipe cuttings and other abrasive materials from pipe lines. It can be instantly cleaned by opening blow-off valve in flange.

In sizes up to 2", these strainers are available with Stainless Steel or Monel Metal basket. Monel Metal mesh basket is recommended. In sizes above 2", perforated plate Stainless Steel is recommended. Available with 20 or 40 mesh screen.



McAlear No. M-258
Spring Operated
PRESSURE REDUCING REGULATOR

Sizes: ½" to 1½"

Reduced pressure 5 to 150 lbs.
Maximum inlet pressure 250 lbs.

Delivers close limit reduced air or gas pressure within the range of 5 to 150 lbs. Also used to control water or steam pressure. Easily and quickly adjustable. Bronze or semi-steel body, bronze or stainless steel trim.

CLIMAX INDUSTRIES INC.

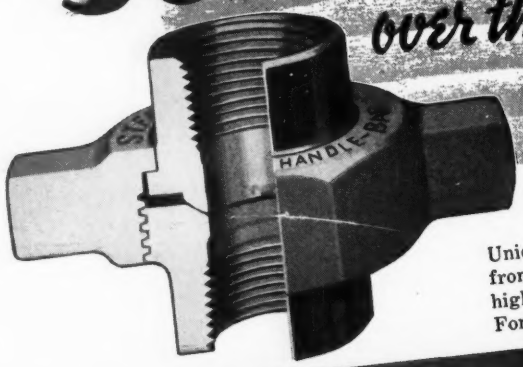
McALEAR
PRESSURE · FLOW · LIQUID LEVEL · TEMPERATURE
controls
for STEAM, WATER, AIR, OIL or GAS

For Full Data

on McAlear Pipe Line Strainers, send for Bulletin 128-A. Address McAlear Manufacturing Division, Climax Industries, Inc.,

1915 South Western Ave.,
Chicago 8, Illinois.

Service over the years with FORGED STEEL UNIONS



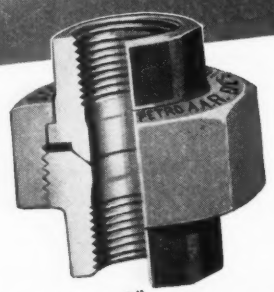
Unions are hot forged from solid round bars of high quality Open Hearth Forging Steel.

Handle-Bar

Hi-Speed Handle-Bar Unions with integral steel to steel seats, or completely fused bronze to bronze seats, black or Udylite (cadmium plated) — sizes from ⅜" to 4" inclusive in 4000 test, sizes 2" to 4" inclusive in 6000 test.

4000 Test Unions furnished with Briggs Standard steam threads in pipe ends, whereas the 6000 Test Union has long pipe ends with API line pipe threads. Nut threads are modified Acme to facilitate easy and speedy assembly and disassembly. Seat design is a 45 degree cone, machined and cold rolled, to a ball seat on male end. Handle-Bar Unions are recommended for all services where they are made up and taken down frequently.

Petro



Sizes ⅛" to 3"

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S. W. P.-2000 lbs. C. W. P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is used.

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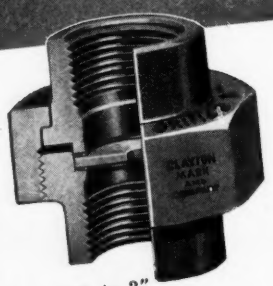
Ideal for flow control of Steam, Oil, Ammonia, Water, Gas or Air. Also for metering and measuring. 600 lbs. S. W. P. or 2000 lbs. C. W. P. The ORIFICE plate is furnished in cold rolled 18-8 stainless steel. ORIFICE plate and gaskets are set in a groove of solid steel to safeguard against blowing of gaskets and resultant trouble. The ORIFICE union has extra heavy ends and nut with the nut threads permanently lubricated.



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ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS SINCE 1912

CLAYTON MARK & COMPANY

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43 Self-Cleaning Strainers—Bulletin A-12 is a four-page bulletin which describes this company's recently announced self-cleaning strainer. Construction of the strainer is completely described and the accompanying illustrations also show construction and, further, serve to supplement the section on "How It Operates." A table of dimensions is accompanied by dimensioned drawings. Elliott Company.

44 Venturi Tubes, Nozzles — Bulletin 450, 4 pages, covers this company's new Type TG insert venturi tubes and nozzles. Construction and installation details are given and a listing of advantages presented. Line drawings point out these features. The last page of the folder is a data sheet for ordering nozzles and tubes. Simplex Valve & Meter Co.

45 Prefabricated Pipe Units—Designed so that it will be of greatest practical use to engineers is a new bulletin, Form 4626, which gives specifications for underground pipe distribution systems employing prefabricated insulated pipe conduit. It is a comprehensive compilation of data arranged in convenient tabular form with supplementary diagrams and charts. The Ric-Wil Co.

46 Metal Hose Handbook—An exceptionally well put-together handbook on flexible metal hose is Catalog G-47, issued recently. Practically every application for metal hose is covered extensively in the handbook. Many tables of sizes, illustrations of hoses and applications are presented. "Instructions for Hose Installations," is accompanied by bar charts. "Guide to Correct Installations," is a section which gives practical installation hints. Information of this general type follows throughout the 72-page book. The company asks that those requesting copies do so on their company letterheads. Chicago Metal Hose Corp., Maywood, Ill.

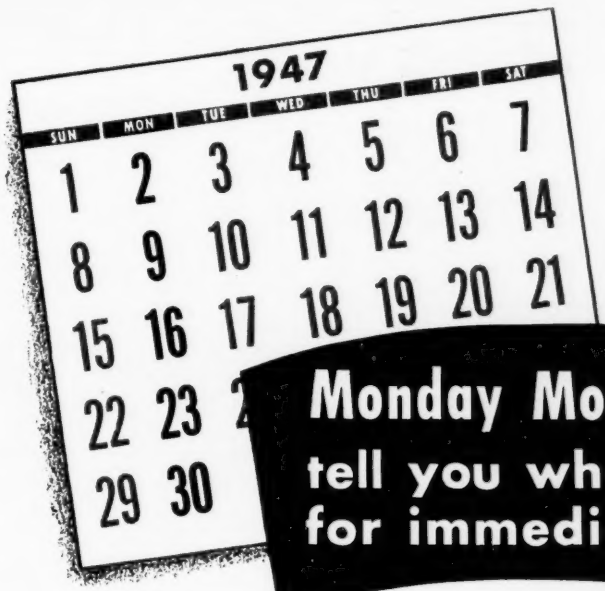
MISCELLANEOUS

47 Roof Maintenance Folder — Roof maintenance for the plant maintenance man is discussed in a large newly published folder designed to interest all plant owners and operators. The booklet is titled, "Is Your Roof a Fair-Weather Friend?" The maintenance guide points out that extra years of service can be gotten from any type of roof and describes the method of stopping leakage, renewing dried-out roof surfaces, repairing flashings and gutters, etc. The folder is well illustrated. Stonhard Company.

48 Tools—These two bulletins—F-10 and BE-14—describe, respectively, a reversible ratchet socket wrench and soft-face hammers and mallets. Outstanding features of the tools are pointed out and illustrations show advantages in operation. Prices and dimensions of three different size wrenches are given in tabular form. Greene, Tweed & Co.

49 Chemical Process Equipment—Catalog 120 describes steel and alloy chemical process equipment for use in the drugs, oil, paint, packing, rayon and other industries. The bulletin consists largely of illustrated material accompanied by thumbnail descriptions of each piece of equipment. Mixers and agitators and steam generating equipment also are described. Edge Moor Iron Works, Inc.

50 Diesel Engines, Generating Sets—This bulletin describes power units of 3¼ to 56 hp, generating sets from 2000 to 36,000 watts and marine propulsion engines 3¾ to 62 hp. Operating principle and a description of the simplicity and economy of operation of the units are covered in the first several pages of the bulletin. Typical installations of the units on river boats, in machine shops, fruit farms, foundries and hatcheries are presented. R. H. Sheppard Co.



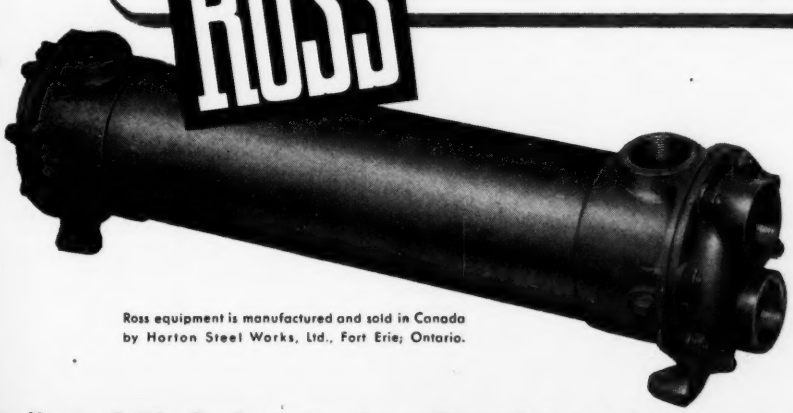
Monday Morning Stock Lists tell you what's available for immediate shipment...

MAINTAINING a substantial stock of Ross Standard "BCF" Coolers as "shelf goods" is a natural outgrowth of the steady, widespread demand for these small, light weight units.

Each Monday morning all Ross offices and representatives receive a fresh stock list showing the size and quantity of "BCF" Coolers available for shipment within 24 hours following receipt of orders in Buffalo. (Sometimes shipments can go forward the same day, if urgently needed.)

So, for oil, water and other fluid cooling that requires a compact, efficient unit, check with your nearest Ross representative about the standard "BCF" line. He can tell you not only what sizes are immediately available and in what quantities, but will quote you costs from published price and discount lists.

ROSS "BCF" COOLERS



Ross equipment is manufactured and sold in Canada by Horton Steel Works, Ltd., Fort Erie, Ontario.

☆ For design details of Ross "BCF" Coolers, write for Bulletin 4922 on your Company letterhead.

Ross Heater & Mfg. Co., Inc. Division of American Radiator & Standard Sanitary corporation **1428 West Ave., Buffalo 13, N. Y.**

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS

51 **Steam Generators**—Catalog almost completely devoted to cross-sectional drawings with accompanying listing of principal data of typical installations in rubber companies, steel works, sugar refineries, muncipal plants, etc. Details of furnace water wall construction on inside back cover; 16 pages. Henry Vogt Machine Co., Inc.

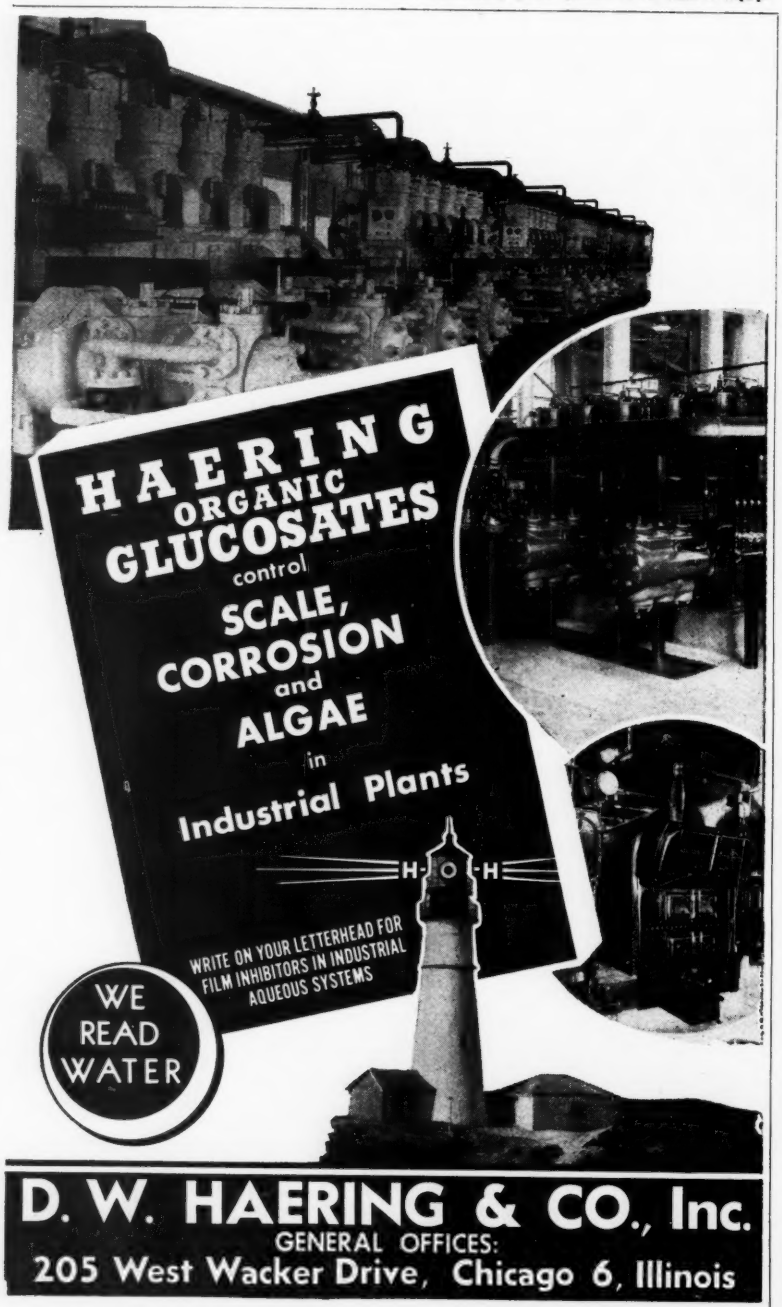
52 **Double-Pass Boilers**—Bulletin RM-1 (6th edition); illustrates and describes this line of riveted or welded double-pass steel firebox boilers. Three full pages of dimensions, ratings and other details including dimensioned line diagrams; 8 pages. The Brownell Co.

53 **Boilers, Burners, Accessories**—Bulletin GC-10; condensed catalog of regular products for stationary power plants. Each class of equipment summarized and illustrated. Well illustrated with line drawings and photographs. Illustrations accompanied by brief descriptions; 12 pages. Combustion Engineering Co., Inc.

54 **Standardized Boilers**—Bulletin 746; 4 page bulletin presenting construction and operation information and ordering specifications for this company's Type M boilers. Bulletin illustrated, presents table of measurement and data. Springfield Boiler Co.

55 **Steam Generators**—Presents reasons for high efficiency; shows brief case histories of plants. Results of tests by independent authorities and "Facts You Should Know About Steam Generating Units." Ratings, dimensions and other data presented. Springfield Boiler Co.

56 **Steam Generator**—Bulletin 119; company's Type S steam generator described and features of construction are pointed out. Folder well illustrated and dimensioned drawing and table of dimensions and sizes are given. Union Iron Works.



PRIME MOVERS

57 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. The Terry Steam Turbine Co.

58 **Multi-Stage Turbine**—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

59 **Turbines, Pumps, Products**—This 24-page catalog covers the company's complete line of products from steam turbines to flexible couplings. Every product is discussed from the design and operation angles and the discussion is heightened in interest by the inclusion of many excellent photographs. Other products discussed are helical gears, centrifugal pumps, multistage pumps, screw pumps, blowers, compressors and speed reducers. De Laval Steam Turbine Co.

60 **Turbine Cleaning Manual**—This 20-page bulletin covers the step-by-step solvent and manual cleaning of turbines from the inspection and preliminary cleaning to draining and final inspection. The cleaning of bearings and governor, installation of filter unit, circulation of cleaning solvent, and displacemet of cleaning oil with new lubricating oil are steps which are covered briefly but clearly. Shell Oil Company, Inc.

61 **Steam Engines**—Bulletin No. 306; Engineering data; tabular material, descriptions; 8 pages. Troy Engine & Machine Co.

62 **Generating Sets**—Bulletin No. 108; General descriptions, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

63 **Stationary Diesel Engines**—Dependability, adaptability of Diesel power described and applications pointed out. Its economical and simple design is stressed. Advantages of company's equipment brought out; exceptionally well illustrated; 24 pages. Enterprise Engine and Foundry Co.

ELECTRICAL

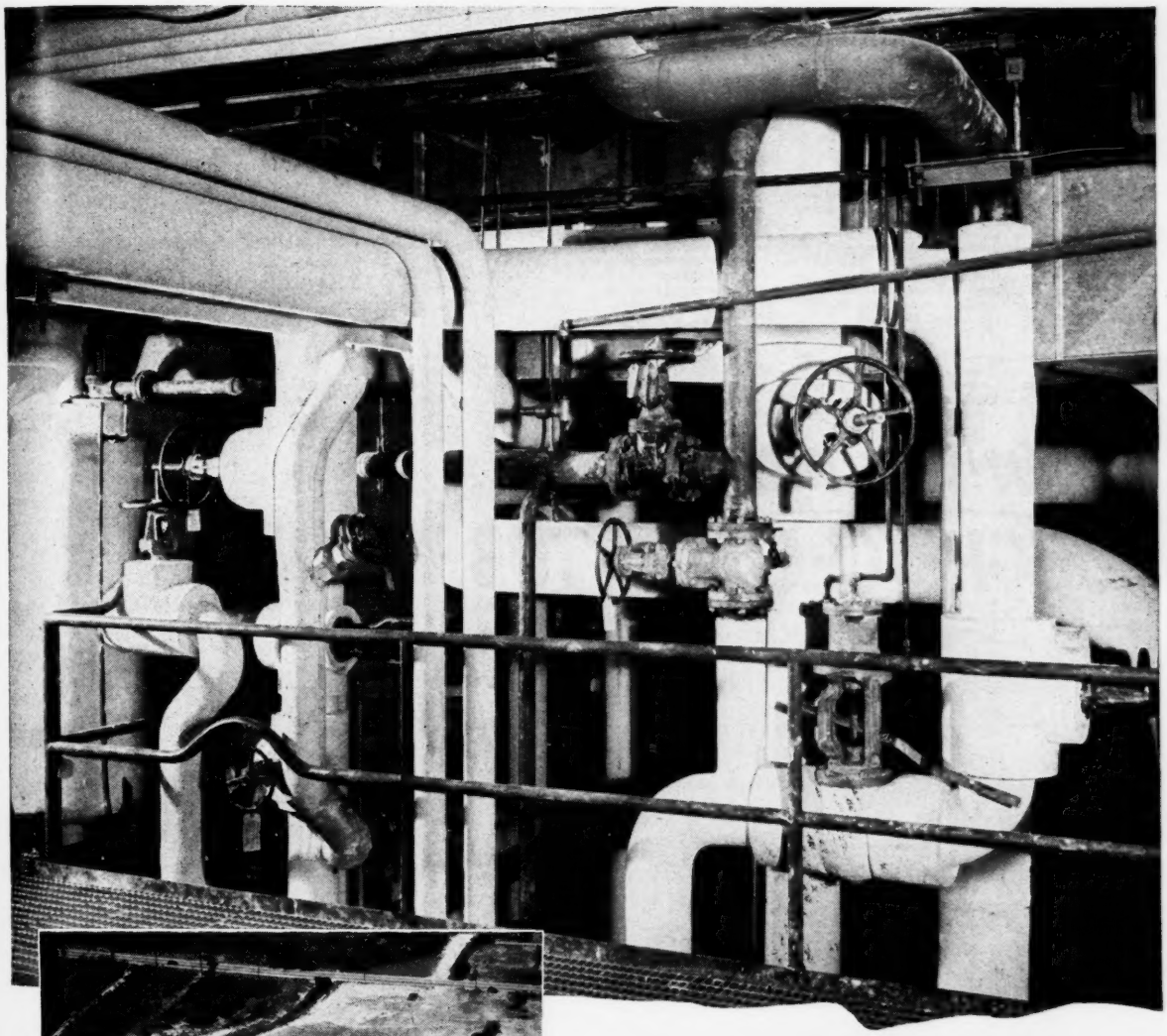
64 **Oil Circuit Breakers**—Bulletin 71B-6421 describes Unitop oil circuit breaker; ratings from 15 to 46 kv, 500,000 to 1,500,000 kva interrupting capacity. Well illustrated. Allis-Chalmers Mfg. Co.

65 **Generating, Substation Equipment**—Bulletin 25B6150 titled "More Power to U.S.A." 32 pages; sketches coverage of the company's equipment from hydro and steam turbines to switchgear and circuit breakers. Unusually well illustrated. Allis-Chalmers Mfg. Co.

AUXILIARIES, ACCESSORIES

66 **Strainers and Separators**—Bulletin 46-50; describes complete line of company's strainers and separators. Dimensioned drawings and photographs; tables of sizes and complete description of applications, operation and design; 16 pages. American District Steam Co.

67 **Atomizing Deaerators**—Bulletin 4160; 3 color drawing illustrates description of principle of operation. Advantages of deaerators are described and illustrated; marine deaerators also covered; 20 pages. Cochrane Corp.



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68 **Condensate Return System**—Description of operation and possible savings accompanied by line diagram and description of how "Jet-Loop" works; typical installation pictured and described. Drawings and text show proven results from experience of users. 2 page spread of drawings and table of dimensions; 16 pages. Cochrane Corp.

69 **Low Pressure Evaporators**—Description of L. P. evaporators; types of evaporator plants, listing of advantages of L. P. submerged tube evaporators. Line diagrams illustrate principles brought out in descriptions. Typical installations are considered and analyzed; 12 pages. Condenser Service and Engineering Co., Inc.

70 **Power and Industrial Equipment**—Bulletin Q-12; describes and illustrates company's equipment for power and industrial use—steam turbines, motors, generators, feedwater heaters, turbochargers steam jet ejectors, centrifugal blowers. Exceptionally well illustrated; 20 pages. Elliott Co.

71 **Heat Exchanger**—This new bulletin describes the company's Twin G-Fin Section; Bulletin 1614; section characterized as universal heat exchanger. Bulletin tabulates 21 features and corresponding advantages, describes design and construction. Installation views shown, field reports included; 16 pages. The Griscom-Russell Co.

72 **Evaporators**—Bulletin 364 describes, illustrates evaporators for various capacities and pressures; contains sections of special interest to plant engineers and executives; includes explanation of functions of evaporators, benefits obtained by their use; different types of evaporating systems and their association with plant balance. 26 pages. The Griscom-Russell Co.

73 **Soot Blowers**—Bulletin F45; soot blowers in general are described. Description and operation of units, materials and specifications and other pertinent information is presented; tables of steam consumption, boiler efficiency, fuel saving chart; boiler cross-sections with blower locations indicated thereon and installation drawings and data are included; 10 pages. Marion Machine, Foundry & Supply Co.

74 **Water Heater Capacity Ratings**—14 tables are included in this ratings booklet showing capacity ratings per hour for temperature rises of from 20 deg (50 to 70 deg) up to and including ratings for a 150 F temperature rise (50 to 200 F). Table No. 15 presents the rate of flow of steam through pipes with steam from an initial gage pressure of one pound up to 150 psi. Marion Machine, Foundry and Supply Co.

75 **HP Extraction Heater**—Bulletin M-302 describes and illustrates the company's patented high pressures closure, Multilok. The features and advantages of the closure as compared to other types of construction are fully described in this 8-page bulletin. The Lummus Co.

76 **Coal Weighing Scales**—Description; outstanding features, specifications, line drawings, photos; 4 pages. Beaumont Birch Co.

77 **Rack and Pinion Gates for Coal and Ashes**—Ball-bearing, dust-tight features; photos, specifications, drawings, tables of dimensions; 4 pages. Beaumont Birch Co.

78 **Steam Specialties**—Collection of folders; steam trap, air trap, reducing valves, classes E, B and H pump governors, automatic boiler feedwater controller; parts and unit list prices; descriptions; illustrations; tables of capacities. The C. E. Squires Co.

79 **Deaeration**—Data book; No. N-15 gives reasons for and principles of deaeration; cold water deaeration; tabular drawing and chart material presented; well illustrated; 20 pages. Elliott Co.

80 **How to Choose a Steam Trap**—Trap selection, trap rating, trap capacity factors, individual trapping, determining lift; traps for unit heaters, pipe coils, fan system heating surfaces, steam jacketed kettles, autoclaves, laundry equipment, paper makers, etc.; installation, operation, maintenance, instructions; specifications and capacities; corrosive service; 42 pages. The V. D. Anderson Co.

WATER TREATMENT

81 **Index for Calcium Carbonate**—Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

82 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

83 **Water Treatment**—Scale and corrosion control in potable water supply; reprinted paper presented by Hanlon, Steffen, Rohlich and Kessler; 12 pages. National Aluminate Corp.

84 **Water Conditioning Service**—"The 6 Fundamentals of Betz Water Conditioning Service" illustrates and describes how this company extends a supervisory service for boiler water conditioning. Booklet shows complete operation of these 6 steps; 16 pages. W. H. & L. D. Betz.

85 **Water Softeners**—Bulletin 607; benefits and economies of soft water; typical applications; how it works; types; design and features; backwash and brine rinse regulators; how to modernize present softener; aerators, degasitors, chemical feed systems, chemicals; 20 pages. Elgin Softener Corp.

86 **Softener Handbook**—Manual, semi- and full-automatic zeolite water softeners are covered in Bulletin 315. Water softener plant is discussed in the first section and operating cycles and plant supervision is next considered. The third section is "Selecting Manual or Automatic Equipment"; this is accompanied by a table of comparison data. Graver Tank & Mfg. Co., Inc.

87 **Sludge Reactivator**—Illustrated booklet, 8 pages, fully explains the principle of upward sludge filtration and describes its adaptability to industrial and municipal water supplies. Charts, flow diagrams and cut-away drawings show clearly how equipment softens and clarifies raw water, materially reduces reaction time and provides, in many cases, a water that is suitable for process work without further treatment. Graver Tank & Mfg. Co., Inc.

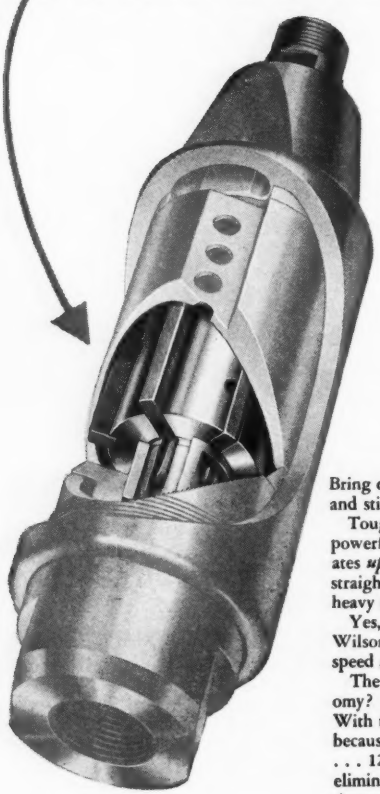
88 **Hot Process Water Treatment**—Form 326 is a case study bulletin; covers results of an installation of the company's hot process equipment at Kankakee Ordnance Plant. System was designed to provide 60,000 gph of properly conditioned water, free from hardness, scale forming minerals and corrosive gases. Graver Tank & Mfg. Co., Inc.

89 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Products, Inc.

90 **Industrial Water Treatment**—Micro-biological Control of and Through Industrial Waters; spot summaries of improvement of process efficiency and product quality of proper sterilization. Wallace and Tiernan Products, Inc.

91 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important considerations in chemical treatment of cooling water circuits. Wallace & Tiernan Products, Inc.

Show this motor your TOUGH-TO-CLEAN TUBES



Wilson EP Series Air Motor with Model F Cutter Head.

Bring on your clogged up tubes with the heavy deposits and sticky scale!

Tough-to-clean tubes are "duck soup" for this extra powerful Wilson EP Series motor. Size for size, it generates *up to 40% more power*—on the curves or in the straightaway—than ordinary motors. It drives through heavy deposits without stalling or slipping.

Yes, after years of proven performance, this same Wilson EP Series motor still leads the field for power, speed and economy.

The secret of these extras in power, speed and economy? It's in the six-bladed, light-bladed construction. With the EP motor you get higher torque at any speed because six blades produce a smoother flow of power . . . 12 powerful impulses per revolution. Light blades eliminate the need for expensive cylinder replacement. Automatic valving of operating air means less air-consumption . . . a minimum of back pressure. Its six blades eliminate "dead" center . . . make it easy to start—hard to stall. Why not see your local Wilson Representative about cost cutting EP Motors today?

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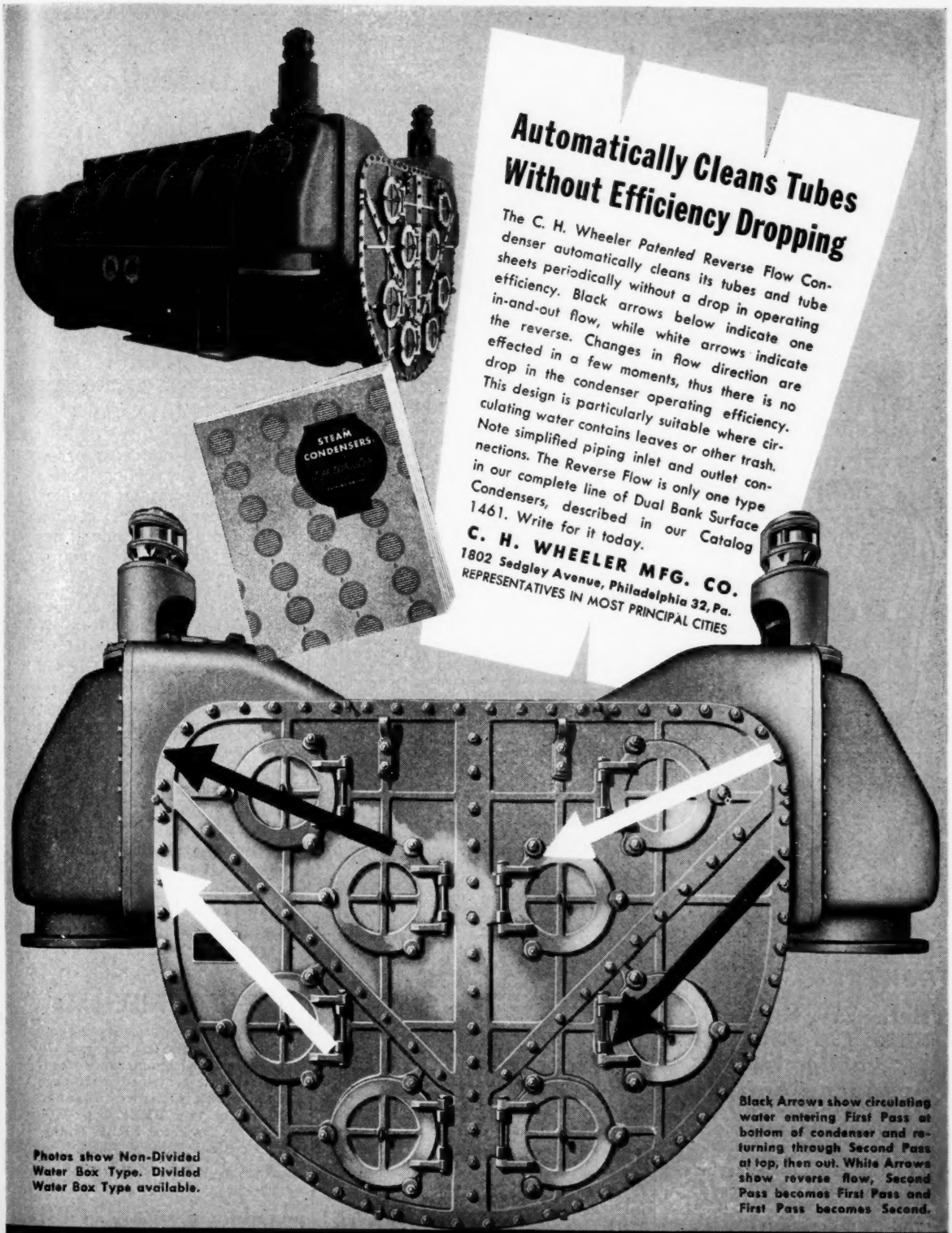
Cable Address: "TUBECLEAN", New York

WILSON
TUBE CLEANERS



Automatically Cleans Tubes Without Efficiency Dropping

The C. H. Wheeler Patented Reverse Flow Condenser automatically cleans its tubes and tube sheets periodically without a drop in operating efficiency. Black arrows below indicate one in-and-out flow, while white arrows indicate the reverse. Changes in flow direction are effected in a few moments, thus there is no drop in the condenser operating efficiency. This design is particularly suitable where circulating water contains leaves or other trash. Note simplified piping inlet and outlet connections. The Reverse Flow is only one type in our complete line of Dual Bank Surface Condensers, described in our Catalog 1461. Write for it today.

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Photos show Non-Divided Water Box Type. Divided Water Box Type available.

Black Arrows show circulating water entering First Pass at bottom of condenser and returning through Second Pass at top, then out. White Arrows show reverse flow, Second Pass becomes First Pass and First Pass becomes Second.

C.H. Wheeler

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92 **Water Treatment**—Chlorine Destroys Ammonia, by A. E. Griffin. Gives data on use of chlorine for elimination of ammonia from boiler feed water. Wallace & Tiernan Products, Inc.

93 **Clarifying and Softening Water**—Eight-page catalog "Reactivator for Clarifying and Softening Water by Upward Sludge Filtration." First part of the booklet tells how the reactivator works and how the sludge blanket is kept in control so as not to flow out with the clarified water. Line diagrams illustrate the principle of operation. Graver Tank & Mfg. Co., Inc.

94 **Feed Water Treatment**—This four-page folder tells how the company's engineering applied to boiler feed water problems can result in savings. It tells of the different procedures and presents diagrams of equipment arrangement. Typical installations in dairy, cosmetic, aircraft, laundry, and other plants are pictured. Illinois Water Treatment Co.

95 **Chemical Feeding and Proportioning**—Bulletins 1100 and 1713A; use of adjustable chemical feeder for water treating, sewage, chemical processes, petroleum; plan and sectional diagrams; descriptions; photos; general specifications; 2-page table of capacity schedules; list of chemicals handled; accessories; drawings of boiler water conditioning systems; 5-page description of method of automatic intermittent feed of conditioning chemicals direct to the boilers; 20 pages. Proportioneers, Inc.

96 **Automatic Proportioning**—Bulletin 1200, 28 pages. Handy reference book containing wealth of information on automatic flow responsive equipment and methods in continuous process operation. Photos of equipment and installation are supplemented by many flow diagrams and detail drawings. Complicated subject made exceptionally clear and understandable by careful arrangement and two-color diagrams. Proportioneers, Inc.

97 **Chemical Proportioning Equipment**—Bulletin 1714 covers chemical proportioning equipment for sea-going service. Two units—for high or low pressure—are described fully. Tabular material assists in the description. Proportioneers, Inc.

98 **Water Conditioning Instruction Booklet**—Bulletin 28X6385 was written especially for guidance of power plant operators. It touches upon importance of feedwater control, care of testing equipment, obtaining samples, test procedures. Handy reference tables given as aid to reporting results. Allis-Chalmers Mfg. Co.

99 **Complete Water Conditioning Service**—This four-page bulletin describes this company's complete water conditioning service—analysis, design, fabrication, installation and maintenance of water treating equipment. Typical installations are pictured and brief sketches of the men behind the service are given. Graver Tank & Mfg. Co., Inc.

COATINGS, TREATMENT

100 **Protective Coatings**—4-page folder 844-246 describes Bitumastic Hi-Heat Gray, a specialized industrial protective coating which is said to resist corrosion and temperature up to 1200 F. The folder is in 2 colors and contains several photographs of equipment on which Bitumastic has been applied. It also gives a list of uses for the material and a chart giving its characteristics. Wailes Dove-Hermiston Corp.

101 **Fuel Oil Treatment**—A 4-page bulletin, telling about the company's treatment for fuel oil called "No Sludge." Advantages of using the treatment such as stepping up efficiency and reducing operating costs are explained. A list of dosages and applications is also given. A free test offer of the treatment is explained on the first page of the bulletin. Dominion Chemical Co., Inc.

102 **Flue Cleaner**—The company's soot and fire scale removing compound is described in this six-page folder. Results obtained from the use of this compound are described in the first part of the folder and then a list of the things which the company guarantees the material will accomplish are listed. Tables of dosage are presented and another table shows losses due to soot and fire scale. Dominion Chemical Co., Inc.

103 **Boiler Rust Treatment**—This four-page bulletin describes the company's "Rustoff" chemical which is said to "build resistance to rust and scale corroded and congested pipes." The bulletin tells how the treatment works and what results may be expected from its use. A brief description of the company's service department is included. Dominion Chemical Co., Inc.

104 **Fuel Oil Treatment**—Several bulletins have recently been announced by this company describing completely the application and effect of its fuel oil treatment compound and Diesel engine solvents. Wilcolene Mfg. Co.

HEATING, COOLING

105 **Cooling, Heating, Air Conditioning**—Collection of bulletins; installation, design, construction data, capacity ranges, condensed

Descaling Mercury Arc Rectifier Cooling Systems

When scale builds up excessively in the cooling system of your mercury arc rectifiers water flow is reduced, cooling retarded and the general operating efficiency of the equipment impaired.

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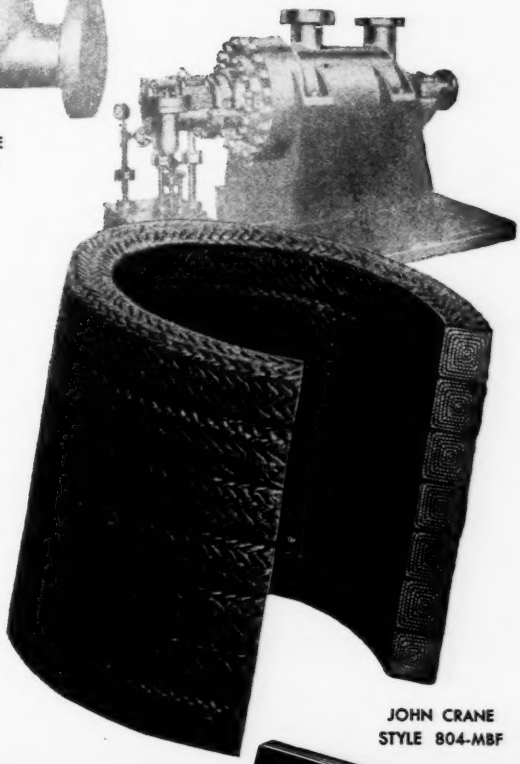

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Style 6-AM, Large Power Plant, Painesville, O.

. . . Excellent service with steam on stop valves at 2000 p.s.i. and 950° F. Plant has standardized on 6-AM . . .

Construction: **Pure asbestos jacket, monel wire reinforced. Plastic Core. Thousands of pounds used by the Navy for high temperature valves and expansion joints. Order in spools, coils, die-formed rings or sets.**

Style 804-MBF, Large Power Plant, Chicago, Ill.

. . . Eighteen months service on boiler feed pumps handling 310° F. feedwater at suction of 275 p.s.i., discharge of 1600 p.s.i. and 3500 r.p.m. Shaft sleeves 600 Brinnell. Packing replaced only because pump was overhauled . . .

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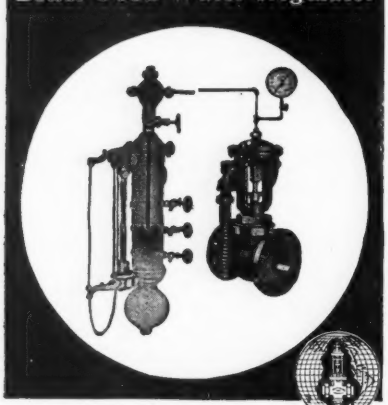
Boiler Feed Water Regulator



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- **No Thermostats**
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The CAMPBELL controls all types and sizes of boilers. Slightest change in water level operates the largest control valve instantly. Easily and inexpensively installed. Dependable. Rugged. Efficient. Economical. No fine adjustments. Nothing to get out of order. 50 to 400 lb. pressure. Sizes 1 to 6 in. Guaranteed.

The CAMPBELL includes a Pressure Indicating Gauge which can be placed on the switchboard or control board, showing precisely what the regulator is doing at all times.

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physical data, numerous photos of installations, full page color diagrams of flow of air, compressed air, water, water spray, etc. Niagara Blower Co.

INSULATION

107 **Industrial Insulations**—Block, blanket insulations; pipe covering; new pressure coverings; insulating cement; felt; Koldboard; fill insulation; diatomaceous earth products; uses, specifications, applications, preparation; charts; photos; list prices; 26 pages. Baldwin-Hill Co.

108 **Insulating Cement**—East of application, efficiency; ease of maintenance application recommendations; heat loss calculations, 4 pages. Baldwin-Hill Co.

STOKERS

109 **Air-Cooled Stoker**—Catalog R-A; features of construction; how timing device works; installation drawings, ash discharge, air cooling features; features of front end driving mechanism; engineering data tables; 20 tables. American Engineering Co.

110 **Water-Cooled Stoker**—Catalog W; drawings of installations; features; furnace views; 8 pages. American Engineering Co.

111 **Spreader Stoker**—Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

112 **Pneumatic Spreader Stoker**—Three-fold booklet on the inner pages of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

113 **Poweram Stoker**—Bulletin 7121; essentials of successful stoker; fuel control, fuel conveying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

114 **Coal Reference Bulletin**—Bulletin 8, Underfeed Stoker Firing, Bulletin covers factors involved in selection of multiple retort stokers, principles, design data and drawings of typical installations; 6 pages. Fairmont Coal Bureau.

115 **Stoker Firing Operation**—Single Retort Underfeed Stoker Firing is the subject of Bulletin Number 9 issued by this Bureau. It is a complete analysis of the advantages of the single retort stoker in the smaller plants. Types of this stoker are described and principles of operation are outlined. Fairmont Coal Bureau.

OIL, GAS BURNERS

116 **Wide Range Oil Burning System**—Bulletin 109; How the system operates; control, drawings; 4 pages. Peabody Engineering Corp.

117 **Oil Burners**—Bulletin 108; Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

118 **Gas Burners**—Bulletin 203; description of A and H gas burners; cross-sectional diagram; photos of atomizers; 4 pages. Peabody Engineering Corp.

OIL, LUBRICATION

119 **Lubrication Recommendations**—Special oils for Diesels and heavy-duty gasoline engines; facts about oil; tables of recommended oils for various models; 18 pages. Standard Oil Company of California.

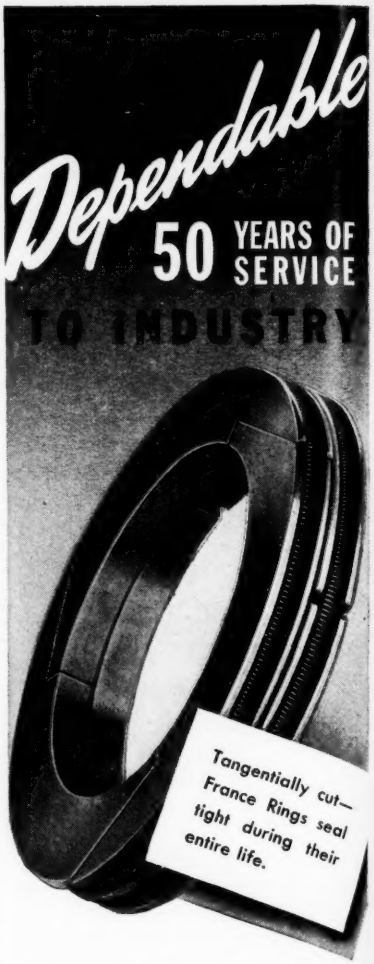
120 **Cutting Fluids**—Facts about cutting fluids; machine tool operations; fundamentals of cutting; how to apply; metallic cutting tools; tabular material; show practices; 50 pages. Standard Oil Company of California.

121 **Diesel Operation**—Relation of fuels and lubricants in the operating efficiency in the diesel engine; diesel fundamentals; maintenance; lubrication and fuels; supercharging; selection and classification of fuels; fuel injection maintenance; improving cleanliness; tabular material, charts, formulas; 114 pages. The Texas Co.

122 **Engineers Report on Oil**—Engine tests, laboratory tests, effects on engines, bearing corrosion, actual service data, filter clogging, service experience; well illustrated with photos and charts; 42 pages. Standard Oil Company of California.

123 **Lubricants Service Handbook**—28 pages in this booklet on lubricants and their application. The development of the lubricant, its features and advantages and the manner in which it meets various operating conditions take up the fore part of the booklet. "Recommendations" section where the manufacturer tells just what grease or oil should be used according to speeds, temperatures, pressures and general service conditions is given. Fiske Brothers Refining Co.

124 **Oil Products for Industry**—Cutting oil, processing oils, general lubricants, refrigeration oils, Diesel oils, solvents, greases and waxes



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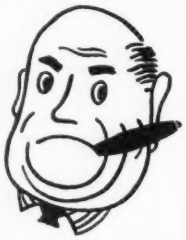

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are among the petroleum products for industry which are described in this four-page folder. The various grades of each oil are analyzed and the reasons why they are fitted to each particular job are given. Sun Oil Co.

125 **Lubricania**—The hundreds of specialized lubricants in use today are identified by certain commonly used tests and terms which describe their physical characteristics. In this dictionary of terms, tests and values, the company has highlighted the most important of these Tide Water Associated Oil Co.

POWER TRANSMISSION

126 **Speed Reduction, Increase Gear**—Bulletin S-130; description; gear cases; gear and pinion; bearings; lubrication; drawings and photos; 8 pages. The Terry Steam Turbine Co.

127 **V-Belt Drive Guide**—Bulletin B6051F; guide to company's complete line of V-belt drives. Contents include types and sizes. V-belt prices, how to figure drives, belt selector charts and tables and similar engineering information. Well illustrated; 12 pages. Allis-Chalmers Mfg. Co.

128 **Chains and Sprockets**—Bulletin D-1; 2 color digest catalog, profusely illustrated, gives pertinent information on drive and conveying chains and sprockets, finished steel roller chains and sprockets, silent chains and sprockets, flexible couplings. Tables of numbers and pitches are given as are full page tables of list prices, dimensions and weights; 16 pages. Union Chain & Mfg. Co.

129 **Flexible Couplings**—Bulletin 57; 2 pages of drawings and tables of ratings for companys flexible couplings. Installations are shown and features of the various types are discussed; 20 pages. John Waldron Corp.

VALVES

130 **Regulating Valves**—Bulletin 1-A; valve data book, description, dimensions and lists of parts; typical installations, rated capacities; prices; 52 pages. Atlas Valve Co.

131 **Pressure Regulator**—Bulletin 1-B; description, installation, operation; list prices; sectional and installation views; parts lists; 8 pages. Atlas Valve Co.

132 **Pressure Reducing Valves**—Bulletin 1-C; sectional drawings, list prices, dimensions and weights; operation and adjustment; capacities for steam and air; 12 pages. Atlas Valve Co.

133 **General Service Valves**—Bulletin E-150; valves for blow-off; fire protection, soot blower lines, acids, process etc.; descriptions; exploded views; features; dimensions, weights and list price tables; parts and parts lists; 14 pages. Everlasting Valve Co.

134 **Valves**—Bulletin E-100; for boiler room service; photos, descriptions, parts; features; pressure rating indexes; size shipping weight and price tables; ordering information; 30 pages. Everlasting Valve Co.

135 **Multiport Relief Valve**—Bulletin 4150; complete description of valves and operating characteristics, photographs of typical installations. Engineering data includes sizing information tables, nomenclature, installation and operation, list of prices of accessories, dimensioned drawings and tables of dimensions; 28 pages. Cochrane Corp.

136 **Steel Valves**—Bulletin 102; 4 page bulletin describing company's "Evrtyte" valves. Cross-sectional illustrations and tables of seat orifice sizes, prices and dimensions are given; listing of features, description of the operation of the unit and parts and prices for assemblies. Strong, Carlisle & Hammond Co.

137 **Diaphragm Motor Valves**—24 pages. Covers Why and How of unit's design. Materials specifications given as are two pages of engineering information and charts. Kieley & Mueller Co.

MAINTENANCE

138 **71 Maintenance Jobs**—This guide tells how better to perform commonly occurring power plant maintenance and cleaning operations. Illustrated manual gives specific material and method recommendations for handling cleaning, degreasing, descaling, derusting, paint stripping, etc. Booklet is completely indexed and reference is made by colored type strips on edge of the pages; 22 pages. Oakite Products, Inc.

139 **Protecting Metal**—High heat resistant coatings for protecting metal surfaces in power and processing equipment are covered in 4 page bulletin. Brief description of properties of coatings are given. The Dampney Co. of America.

140 **Condenser Tube Inserts**—Description of Flowrites; illustrated, accompanied by report of tests on Flowrites made by M.I.T. Tables and charts of test results are presented; description of how to install inserts given; 8 pages. Condenser Service & Engineering Co., Inc.

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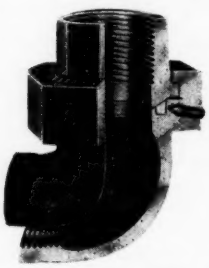

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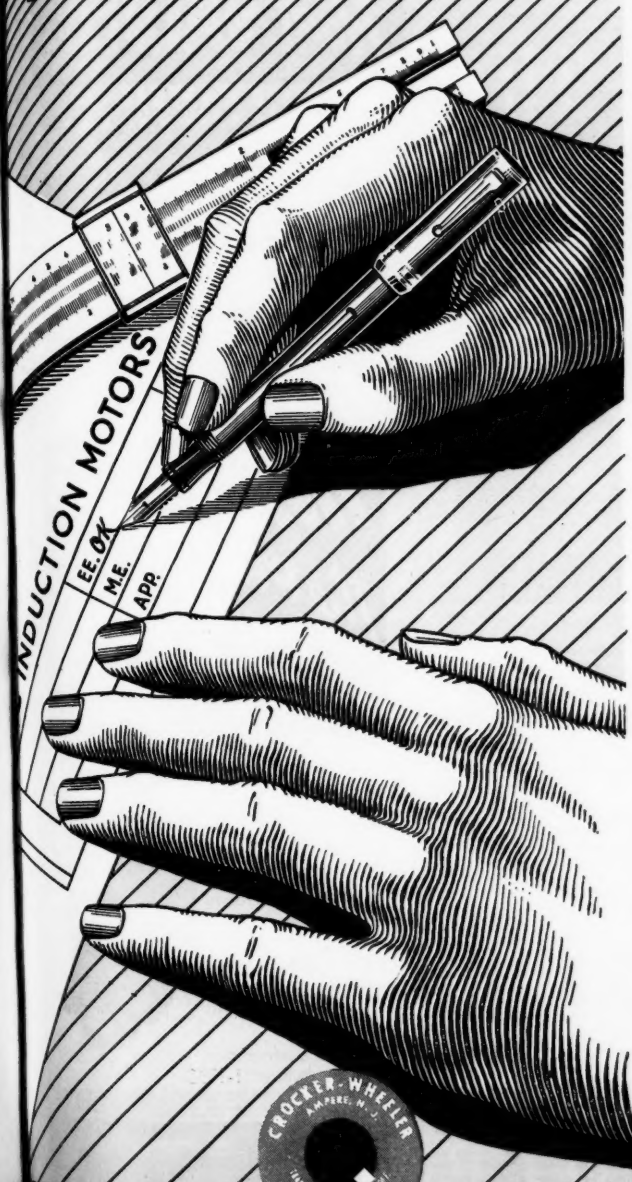

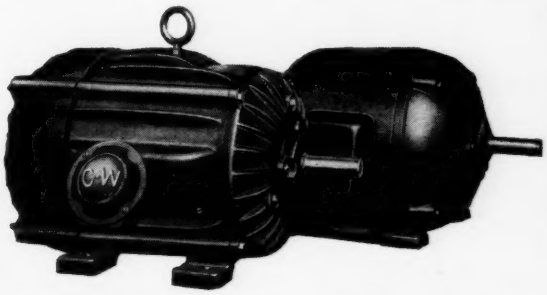

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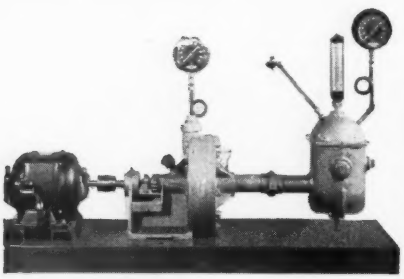
the *direct* *Returnal* WAY



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CONTROLS, METERS

141 **Damper Regulators**—Bulletin 4-A; for low pressure heating, medium pressure power and high pressure power boilers; what they do; how to specify; typical installations (drawings); adjustments; list prices; technical descriptions and parts lists; 20 pages. Atlas Valve Co.

142 **Thermostats and Relays**—Bulletin T, a 12-pg. catalog presents significant information on this company's mercurial thermostats and adjustable thermoregulators. Also included is complete data on relays, designed as companion instruments to the above mentioned. Complete descriptions of the instruments are included and the bulletin is well illustrated. Precision Thermometer & Instrument Co.

143 **Recording Flow Meter**—Bulletin 349; what it does, features, chart of rated capacity; construction and operation; installation drawings, tables of capacity; photos; 8 pages. Builders-Providence, Inc.

144 **Propeller-Type Meter**—Bulletin 350A; for main-line metering; applications, description, installation, materials of construction; features; table of capacity, shipping weights; specifications, drawings; 4 pages. Builders-Providence, Inc.

145 **Centralized Combustion Control**—Bulletin 43-605; applications to various types fuels and burning equipment; controller, measuring elements, pilot device, power unit, etc.; 24 pages. The Hays Corp.

146 **Combustion Meters** — Bulletin 44-550; reasons why it is accurate, dependable, simple, rugged, easy to install, easy to maintain, speedy, easy to understand; well illustrated by explanatory diagrams; 16 pages. The Hays Corp.

147 **Feedwater Textbook**—"Mechanical Feedwater Regulation for Boilers" by Prof. E. P. Culver; principles of feedwater regulation; mechanical equipment available; differential pressure control; feed pump control; illustrations, diagrams, charts; 36 pages. Northern Equipment Co.

148 **Engineering Monographs**—Series of eight on automatic combustion control; 1. How Close Can Steam Pressure Be Controlled? 2. Why Operate Automatic Combustion Control from Changes in Steam Pressure? 3. Adapting to the Characteristics of Underfed Stokers. 4. Adapting to Spreader Type Stokers. 5. Adapting to Chain or Traveling Grate Stokers. 6. Adapting to the Characteristics of Pulverizers. 7. Adapting to the Characteristics of Oil Burners. 8. Adapting to the Characteristics of Gas Burners; total 37 pages. The Hays Corp.

149 **Draft Gages**—Bulletin 46-667; gages for indicating, recording of drafts, pressures, differentials, temperatures; pressure-draft tables; descriptions of equipment; differential units, Bourdon tube units, pointer gages, etc; 20 pages. The Hays Corp.

150 **Draft**—Bulletin 46-472; what draft is; where it is found; how it is measured; what the draft gage tells, where to measure draft and pressure in steam plant; where to connect draft gages; how to install; drawings; 20 pages. The Hays Corp.

151 **Flue Gas Analyzer**—Bulletin 45-668; principle of operation; construction features; technique; models and prices; Burrettes—classifications and uses (table); what flue gas analysis tells us; 16 pages. The Hays Corp.

152 **Indicating, Control Systems**—What they are, what they can do; Bulletin 14B6641. Description of how transmitter, receiver and indicator of systems are constructed, how they work, their advantages and specifications. Illustrated with photographs, diagrams, charts; 12 pages. Allis-Chalmers Mfg. Co.

153 **Water Gages**—Condensed catalog, Bulletin E, of company's complete line of water gages. Each model illustrated and accompanying table gives sizing information; 8 pages. Ernst Water Column & Gage Co.

154 **Stainless Steel Bellows**—Bulletin SSB-46; contains diagrammatic cross-section views and up-to-date information concerning the use of these bellows as equalizers, compensators, expansion joints, flexible connectors for flow control, vapor and steam traps, thermostatic instruments, etc. Completely illustrated; 12 pages. Chicago Metal Hose Corp.

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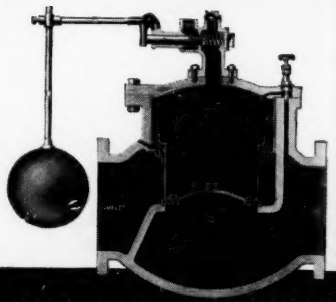

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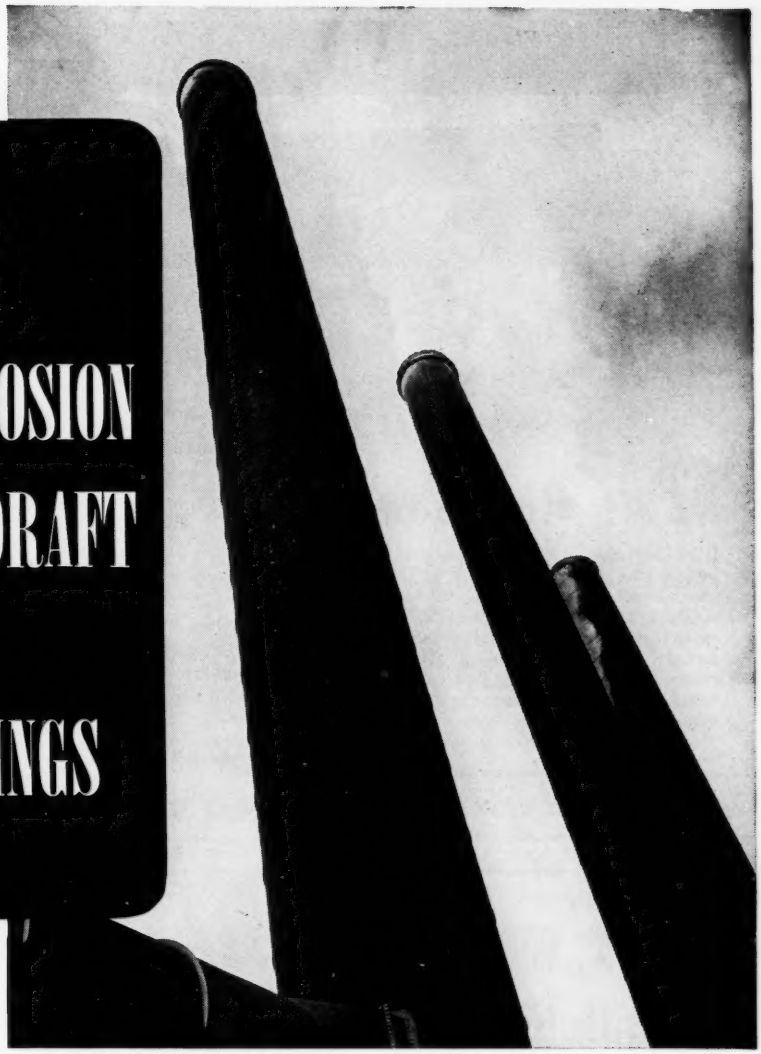

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158 **Temperature Regulators**—Bulletin 7-A; six types; descriptions; list prices, tabular material, photos; list of parts; typical installation drawings; tables for finding sizes of control valves required to heat given quantity of water; 16 pages. Atlas Valve Co.

159 **Draft, Excess Air and CO_2**—Bulletin 39-341; discussion of the relation of these elements to the installation and servicing of bituminous and anthracite stokers by Arnold Soller; 12 pages. The Hays Corp.

160 **Liquid Level Controllers**—Bulletin A-100 is a four-page catalog describing this company's Types G and D liquid level regulators. Excellent cross-sectional views of the units are presented and their operational and constructional features are described. Dimensions, capacities and shipping weights are presented. Stets Company.

161 **Boiler Feed Control**—Bulletin 463, 16 pages, describes boiler feed control systems at Westover, Greenidge and Jennison Stations of N.Y. State Electric and Gas Corp. Completely illustrated with photos and line drawings. Tables of significant data included. Northern Equipment Co.

162 **Water Level Control**—"Controlling Water Level on Combustion Engineering Type VU Boiler," is title of Bulletin 455. These four pages present photos and chart reproductions and tell the details of the company's control equipment on this particular type of boiler. Northern Equipment Co.

163 **Water Level Control**—Bulletin 459, 8 pages, description of water level control installation at Wyman-Gordon Co. Good illustrations show details of installation. Table of significant data given. Northern Equipment Co.

164 **Boiler Water Level Control**—Bulletin 467 and 465, 8 pages each, describe respectively, control installations at Buzzard Point Plant and West Reading Station. Both give exceptionally detailed reports of the installation complete with tables, photos and drawings. Northern Equipment Co.

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166 **Standards for Flanged Fittings, Valves, Flanges**—Pressure temperature ratings, tables and charts, rating procedure, flange materials, safety factors, loading, stress formulas; 20 pages. Tube Turns, Inc.

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169 **Unions**—Complete line of malleable iron unions and convenience unions; illustrations, descriptions, size and list prices; descriptions of materials and workmanship; 24 pages. Jefferson Union Co.

PUMPS

170 **Horizontal Duplex Piston Pumps**—Bulletin 230-1; specifications, steam end, liquid end; capacity tables for pressure service, light pressure service; dimensions, drawing, tables; 4 pages. Warren Steam Pump Co., Inc.

171 **Steam Heat Vacuum Pumps**—Bulletin 226-1; specifications, drawings, general information, tables of sizes and capacities; 4 pages. Warren Steam Pump Co., Inc.

172 **Centrifugal Pumps**—Bulletin 302-30, Revised; instructions for installation and operation; drawings, tabular material; 12 pages. Warren Steam Pump Co., Inc.

173 **Hydraulic Pressure Pumps**—Bulletin 238; specifications, sectional photos, important features; full page table of capacity, sizes, pipe sizes, pressure; 4 pages. Warren Steam Pump Co., Inc.

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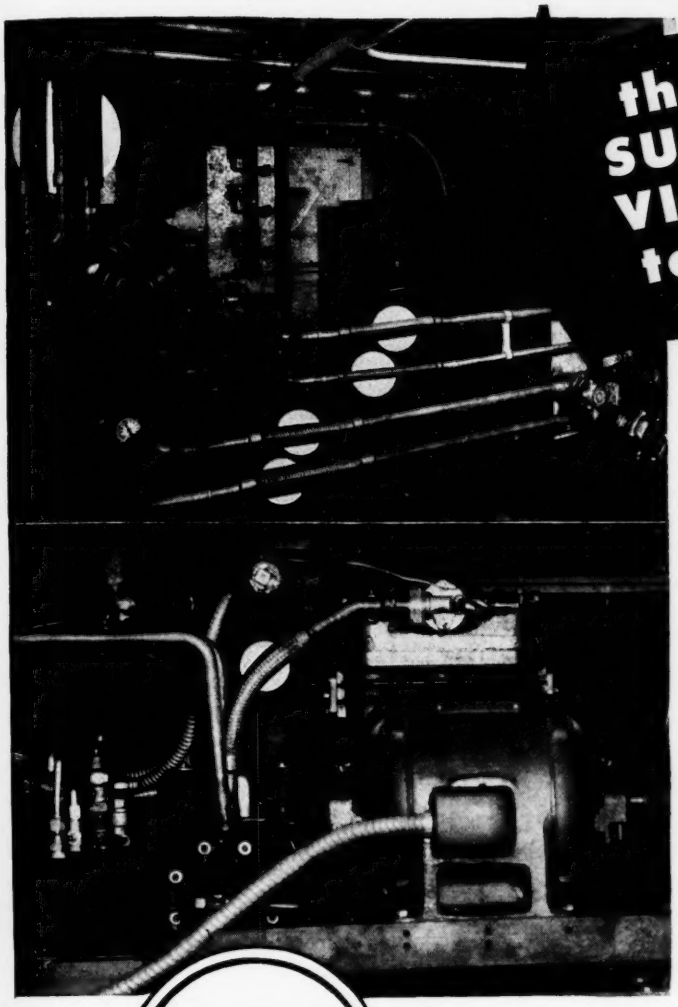

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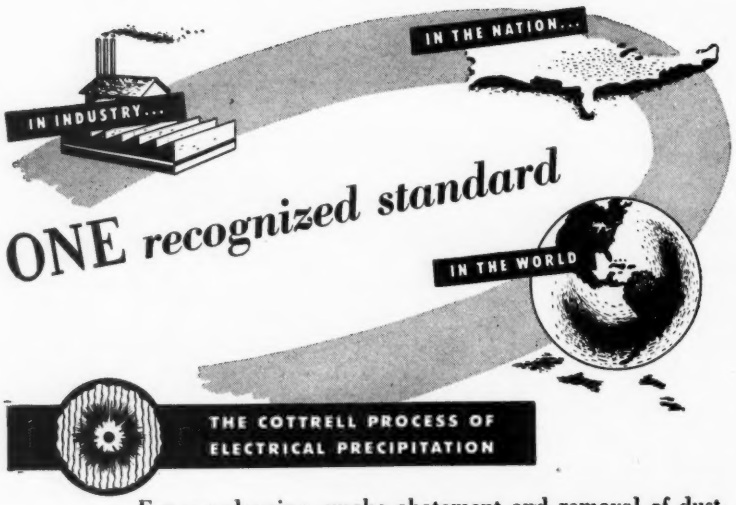

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POWER PLANT ENGINEERING

174 **Screw Pumps**—Recommended uses; advantages; tables of capacities and sizes; charts of test results; dimensioned drawings; suctions and discharge, packing box sizes, shipping weights tables; specifications; installation and maintenance; theoretical horsepowers; viscosity classifications; 18 pages. Sier-Bath Gear & Pump Co., Inc.

175 **Centrifugal Pumps**—Booklet describes basic action of centrifugal pumps, tells of the science of centrifugal action and the physics of pumping. Performance curves are presented. Descriptions of the company's self-priming centrifugal pumps are given and how they operate is explained. Typical uses of the units are pointed out and installation and operation explained; 20 pages. Marlow Pumps.

176 **Centrifugal Pumps**—Bulletin 240, 6-page folder describing single stage, double suction, Type DBL centrifugal pump. Features of the pump resulting from its construction and engineering; a sectional view which is used to point out other advantages of the unit. Tables of metal specifications and capacity ratings in gallons are also given. Warren Steam Pump Co., Inc.

177 **Multi-Stage Pumps**—Bulletin 241 describes 4 and 6 stage Type TM pumps. Cross-sectional illustrations and tables of specifications are given. Dimensioned drawings and tables of dimensions accompany copy describing unit's construction and advantages. Warren Steam Pump Co., Inc.

178 **Close-Coupled Pumps** — Close-coupled pumps, called Compac-units, are described in Bulletin 242. This eight-page bulletin presents clear and understandable cross-sectional photos of the units and uses these to point out construction and operation features. A full-page "Composite Rating Table" presents rating information at various heads for 9 different models of pumps. Warren Steam Pump Co., Inc.

179 **Compressors, Vacuum Pumps**—Bulletin C-5; 16 pages. Describes complete details of construction including illustrative material such as photographs of parts of the units and drawings of detailed structural parts. Tables present size and capacity information. Chart of typical characteristics is given. Fuller Co.

MISCELLANEOUS

180 **Floor Resurfacing**—This recently-published folder describes the methods of use of the company's heavy-duty resurfacer for use on floors, traffic aisles and loading platforms. It contains a concise, clear description of the properties, methods of application and advantages of the resurfacer and is of interest to everyone who has problems in the maintenance and repair of concrete floors. Stonhard Company.

181 **Electric Tools**—Bulletin 464; covers complete line of portable electric tools for construction and briefly describes such tools as electric hammers, drills, chisels, vibrating tools, accessories, screw drivers, etc. Prices are given. Syntron Co.

182 **Refractory Concrete**—"Lumnite for Refractory Concrete"; basic information on materials and methods used in making refractory concrete. Illustrations show application of concrete in construction of furnaces, coke ovens, etc. Another section covers concrete use in foundations, floors and structures subject to high heat: 24 pages. Lumnite Division, Universal Atlas Cement Co.

183 **Gas Purger for Refrigeration System**—Bulletin 160; tells how to cut power costs and raise condenser capacity by proper purging of non-condensible gases. Tables of ammonia properties, advantages and complete illustrated material. Typical installations are pictured. Two pages with diagrams tell how purger operates; 8 pages. Armstrong Machine Works.

184 **Grinding Wheels**—Grinding wheels of various abrasives are illustrated and list prices presented; tables of sizes in inches are accompanied by photographs and line drawings of these various wheels. Grinding wheel dressers with list prices are shown; 32 pages. Norton Co.

185 **Weldments**—Bulletin SP106, tells about the services of this company's weldry and the weldments turned out therein. The products of this weldry are shown and the text points out how flexible the method is by showing that it makes no difference if the finished product is constructed of light sheet or heavy metal . . . the resulting product can be made to exacting specifications. Graver Tank & Mfg. Co., Inc

186 **Drop Forged Flanges** — Manufacturing processes; physical characteristics; full-page tables of illustrations, dimensions, weights and prices. Space provided for future insertions. Phoenix Mfg. Co.

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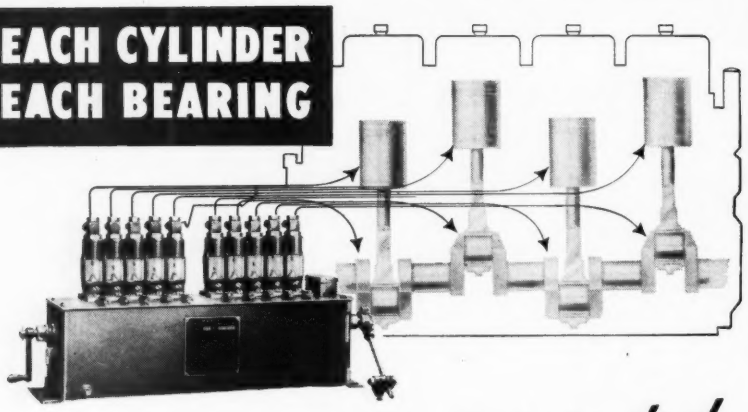

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THE THIRD STEP

(*Continued from page 67*)

monetary value on co-operative effort of this kind, which has made it a matter that ceases to arouse wonder that a light bulb unscrewed from a lamp in New York can be screwed into a socket in Denver; that red lights always mean stop and green lights always mean go through this land of 130,000,000 people; that most screws and bolts can be specified by number rather than by a precise three page description, complete with drawing; or even that we have made a fair start on knowing precisely what the term "rayon" or the term "shoddy" means.

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The widest possible development and use of such well-understood tools of management is interchangeability of parts, standard components, precise units of length, weight, color, smell and visibility are the very key to entrance on the *Third Step* of national progress.

Let me tell you only a few of many projects now under way in this field, any one of which opens up a surprising horizon of saved time, saved money and saved material.

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The Optical Society of America has also, within recent weeks come to the American Standards Association with proposals of standardization in the whole field of optics.

The highly technical series of projects will run all the way from standard terminology, so that technicians may make themselves clear to each other, to the development of standard lenses,

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MANUFACTURERS OF AUTOMATIC CONTROLS FOR HEATING, AIR CONDITIONING, REFRIGERATION AND NUMEROUS INDUSTRIAL APPLICATIONS. ALSO MERCOID BRAND MERCURY SWITCHES.

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Industries' first choice for dependable control performance. The outside adjustment and visible dial eliminate all guesswork when setting the operating range

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Used on a variety of industrial temperature applications. Have same adjustment feature described above.

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Recommended wherever quiet and dependable performance are essential. Various types available.

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Mercoid brand switches are noted for their superior operating qualities. Various types available.

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Available for gasoline, oil, ammonia or other low specific gravity liquids. Also for liquids at high pressures.

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Used for maintaining fluid levels in tanks or for control of sump pumps, etc. Two types, the counter-balance type and plunger type available.

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Valve Stem Packing

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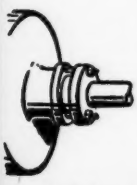

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Can the CAPACITY of a Reciprocating Pump be increased by installing a special-type Water Valve?

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CUBIC EXTENT is commonly defined as "The dimension or degree to which anything is extended; the limit to which anything reaches; size within given bounds."

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prisms, mirrors, mountings and the like, so that optical instruments become in practice what they are in theory, precision devices. It will deal as well directly with the eye, brain and nerve mechanics (psycho-physics) of human vision.

Between such diverse projects fall a whole field of endeavor now being carried on through the ASA machinery from matters of direct interest to the consumer, like the flammability of materials, to those covering the safety of industrial workers, like a recently completed standard on the allowable safe concentration of Trichloroethylene, a common degreasing agent in use in factories.

The ASA Method

Currently the records of the ASA show that over 3,000 industrial, technical and consumer representatives from 660 organizations are participating in the setting of these standards which raise efficiency of American industry.

In no conceivable government regulatory body could such a reservoir of trained technical minds be assembled to solve the problems inherent in our entrance into the *Third Step* of really efficient production in volume for the benefit of the ultimate consumer.

These trained technicians come together voluntarily to solve their own mutual problems and the American Standards Association provides merely the time-tested machinery for them to make their decisions and continue to make these decisions as technology changes, so that standards once arrived at stay constantly valid.

Survival Demands Strength

Only through a highly productive economy can the United States hope for survival indefinitely in a disturbed world. I am convinced that our entrance into the *Third Step* which I have outlined to you, and our uninterrupted freedom to pursue that *Third Step* without outside interference depends primarily on having a strongly functioning national economy.

This economy will be developed solely as we turn our brains to the logical development of the *Third Step*, which means an economy without waste motion, waste material or waste manpower.

We have fought our last extravagant war. Never again will we have the natural resources, the manpower or the managerial brains to squander in a last minute scramble for national security.

We have been through two such scrambles in a generation, and I frankly do not believe that we are capable successfully of going through such a disorganized procedure again.

The first country which really climbs the *Third Step* will make all its other ideas, social, economic and technical, the dominant ones in a world in flux. They can be the ideas of free men, freely striving toward the fulfillment of the world's needs.

I need pose no alternative. The choice of every thinking American is as obvious to you as it is to me.

INSTALL "PENNSYLVANIA" PREPARATION EQUIPMENT

At the power plant—to handle ROM, to prepare free-flowing steam coals, to remove debris and protect conveyors, pulverizers and stokers from possible damage.

At the by-product coke plant—to prepare ROM for blending, do away with all oversize, eliminate mine, rail and yard debris, protect Hammermills and Pulverizers.

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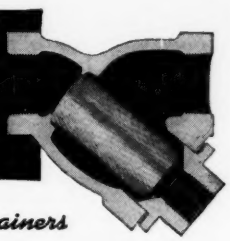

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Self-Cleaning feature allows cleaning the screen without removal from strainer body or shutting-off the operating fluid.

Straight thread and gasket joint on *all* screwed end strainers permits easy removal of screen.

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Body Material	Connections	Size in Inches
Cast Iron Bronze Cast Steel	Screwed or Flanged	¼—8
Forged Carbon Steel	Socket Welding Ends	½, ¾, 1
Cast C-MO Steel		1, 1¼, 1½, 2
Cast Stainless Steel*	Screwed	½, ¾, 1

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SEND FOR Strainer Bulletin 465 containing new chart for computing steam pressure drops through strainers—no obligation.

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...two gage glasses on pressures over 400 psi

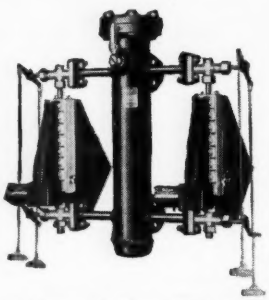
Reliance TWIN GAGE Water Column Assemblies

provide a simple and convenient means of complying with the code

● You adhere to code requirements for maximum safety and efficiency in operating your power plant. It's up to you to select equipment that follows code procedure and gives you *the most satisfactory service.*

Probably the best practice in applying the rule for two gages on boilers operating at over 400 psi, is by means of a *water column assembly.* This provides flexibility of placement, ease of providing mechanical support, greater stability of water level indication, provision of high and low alarm signal if desired (up to 900 psi), and over-all convenience and safety of operation.

"Single water column with two gages" is the most popular selection, according to Reliance experience. Principal water column manufacturer for 63 years, Reliance practice is to give you a wide margin of safety in rugged construction, fully approved welding procedure, and expertly custom-made equipment. Write for information on twin gage water columns.



Reliance Column W73 with alarm; gage inserts with illuminators and hoods.

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W650 Reliance Water Column; double window flat glass inserts.

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is a "duplicate" gage that gives you accurate water level reading at convenient stations—on wall or instrument panel. Models for any pressure. More than 7000 in service.

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POWER PLANT *Construction News*

Fla., Lake Monroe—Florida Power & Light Co., Miami, Fla., has begun construction of addition to Sanford steam-electric generating station at Lake Monroe, and will install equipment for increased capacity. Cost estimated about $1,500,000, including extension in transmission lines.

Idaho, Moscow—Board of Directors, University of Idaho, has plans under way for extensions and improvements in boiler house, used for central-heating service at institution, with installation of new boilers and auxiliary equipment to replace present units. Cost estimated close to $250,000. V. N. Jones & Associates, Republic Bldg., Seattle, Wash., are consulting engineers.

Ind., Anderson—Guide Lamp Div., General Motors Corp., automobile lamps, headlights, etc, is considering plans for extensions in steam-generating station, including installation of new boilers and auxiliary equipment. Cost reported close to $200,000.

Ind., Fort Wayne—Board of Public Works plans new power substation for municipal electric system, estimated to cost about $100,000, with transformers, switchgear and other operating equipment. H. A. Kerby is electrical engineer for municipal Light & Power Dept., 308 East Berry St., in charge.

Iowa, Eldora—Town Council has plans under way for new municipal power plant and electrical distribution system. Cost reported close to $500,000. A bond issue in that amount has been authorized. Buell & Winter Engineering Co., Sioux City, Iowa, is consulting engineer.

Kan., Hays—Colorado-Wyoming Gas Co., Continental Bldg., Denver, Colo. plans new compressor station, capacity about 1200 hp, for natural gas pipe line service in vicinity of Hays. Cost reported about $1,300,000, with compressor units and accessories. Proposed to begin work in near future.

Kan., Plainville—Western Light & Telephone Co., Huron Bldg., Kan., plans expansion and improvements in power plant at Plainville, with installation of new Diesel engine-generating unit and auxiliary equipment. No estimate of cost announced. Joseph W. Radotinsky, Commercial National Bank Bldg., Kansas City, Kan., is architect.

Kan., Riverton—Empire District Electric Co., Joplin, Mo., plans expansion in generating station at Riverton, including multi-story addition to present building and installation of new 30,000-kw turbine-generator, high-pressure boiler and accessory equipment. Cost estimated close to $4,000,000. Black & Veatch Engineering Co., 4706 Broadway, Kansas City, Mo., is consulting engineer.

Ky., Louisville—American Tobacco Co., 1700 West Broadway, has approved plans for new multi-story power plant at local factory, reported to cost approximately $225,000, with equipment. Work on superstructure will begin soon. Francisco & Jacobus, 511 Fifth Ave., New York, N.Y., are consulting engineers.

Ky., Louisville—Board of Directors, University of Louisville, 2301 South 3rd St., is considering preliminary plans for new electric generating station at institution, reported to cost close to $225,000.

Me., Union Falls—Central Maine Power Co., Augusta, Me., plans hydroelectric power development on Saco River near Union Falls, including power dam, power station with hydraulic turbines and generator units, and auxiliary structures. Cost estimated about $3,500,000, with transmission lines. Proposed to begin work at early date.

Mass., Chicopee—A. G. Spaulding & Brothers, Inc., sporting goods, plans installation of electric power equipment in proposed new additions to factory, reported to cost over $3,500,000. Work on superstructure will be placed under way soon.

Minn., Benson—Western Minnesota Power Cooperative, Benson, has completed plans for new generating station on local site, reported to cost over $700,000, with equipment. Work is scheduled to begin soon. It is understood that Diesel engine-generator units will be installed. General Engineering Corp., 2950 Chicago Ave., Minneapolis, Minn., is consulting engineer.

Minn., Lyle—Dairyland Power Cooperative, Inc., Rivoli Bldg., La Crosse, Wis., has authorized plans for new Diesel engine-generating station at Lyle, and will begin work in

near future. Installation will include a 2500-kw engine-generator unit and accessory equipment. Gausman & Moore, First National Bank Bldg., St. Paul, Minn., are consulting engineers.

Minn., Minneapolis—City Council, City Hall, has plans under way for new central steam-electric power plant for electric service and steam supply for city hall, court house and general hospital buildings. Cost estimated approximately $800,000. Long & Thorshov, Inc., 1200 Second Ave. S., is architect; Ralph D. Thomas & Associates, Inc., same address, is consulting engineer.

Miss., Corinth—City Council plans installation of a natural gas distribution system, with pressure pipe line connection with source of supply, control station, meter house and other operating facilities. Cost estimated about $800,000. A bond issue in that amount will be arranged soon.

Miss., Meridian—Flintkote Co., wall board, insulating board and other wood fiber products, has plans in progress for addition to boiler plant at local mill, with installation of new 150-hp boiler and auxiliary equipment. Rust Engineering Co., Liberty National Bank Bldg., Birmingham, Ala., is engineer and will be in charge of erection. Main offices of company are at 30 Rockefeller Plaza, New York, N.Y.

Miss., Mound Bayou—U. S. Corps of Engineers, Mobile, Ala., has authorized plans for new hospital for Veterans' Administration, Washington, D.C., at Mount Bayou, comprising several one and multi-story buildings for institutional service, with boiler house, mechanical laundry and other utility structures. An air-conditioning, electric elevators and other mechanical equipment will be installed. Cost reported over $5,000,000. Bids are expected to be asked in about 6 months. Jamieson & Sperl, Arcade Bldg., St. Louis, Mo., are architects.

N.Y., Dresden—New York State Electric & Gas Corp., Binghamton, N.Y., has preliminary plans under way for expansion in Greenidge steam-electric generating station, Dresden, and will install a new 60,000-kw turbine-generator, high-pressure boilers and auxiliary equipment. It is understood that completion is scheduled in about 24 months. Company also will make extensions in Jennison power plant, Bainbridge, N.Y., where a new 45,000-kw turbine-generator, high pressure boilers and accessory equipment will be installed.

Ohio, Toledo—Toledo Edison Co., Edison Bldg., has approved plans for new addition to local Acme generating station, Front St., and work on superstructure will begin soon. It will be used for expansion in turbine and boiler rooms, with installation of equipment for increased capacity. Cost reported in excess of $2,500,000.

R.I., Saylesville—Sayles Finishing Co., Inc., Walker St., plans new boiler house for service at textile mill. Cost reported in excess of $75,000, with boilers and auxiliaries. Construction will be carried out by day labor. Westcott & Mapes, 109 Church St., New Haven, Conn., are consulting engineers.

Texas, Bryan—City Council has plans in progress for new addition to municipal oil engine-operated power station, with installation of equipment for large increased capacity. Also will make improvements in present unit. Entire project is reported to cost over $1,200,000. Freese & Nichols & Turner, Danciger Bldg., Fort Worth, Tex., are consulting engineers.

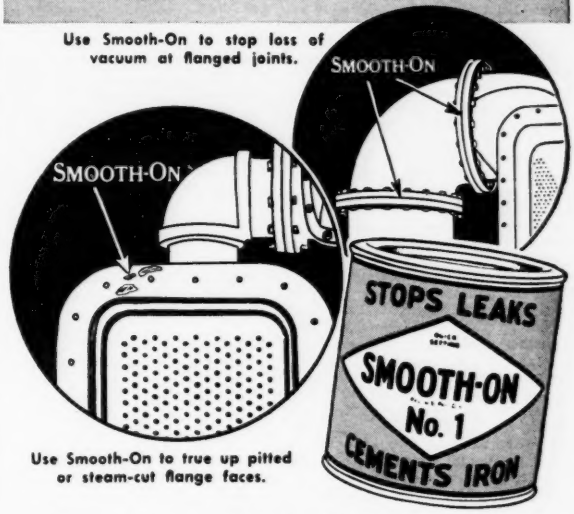
Texas, Houston—Houston Lighting & Power Co., Fannin and Walker Sts., has preliminary plans under way for proposed new steam-electric generating station at Greens Bayou, where large tract of land has been acquired. It will comprise a multi-story building, with turbine-generators, high-pressure boilers and auxiliary equipment for heavy output. Cost reported close to $15,000,000, including transmission line extensions.

Utah, Murray—Town Council has plans maturing for extensions and improvements in oil engine-operated municipal power station, with installation of a new 5000-kw Diesel engine-generator unit and auxiliary equipment. No estimate of cost announced. Thomas C. Adams, Utah Oil Bldg., Salt Lake City, Utah, is consulting engineer.

Wash., Peshastin—Peshastin Fruit Growers' Association, Peshastin, has approved plans for new two-story cold storage and refrigerating plant, estimated to cost over $185,000, with equipment. Erection will be carried out at once.

Wis., Athens—Lake Superior District Power Co., Ashland, Wis., is considering construction of new generating stations at Athens and Hayward, Wis., respectively. Details and estimates of cost will be determined in near future.

How To Save Time and Money on Maintenance Jobs



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NEW ENGINEERING BOOKS

(Continued from Page 134)

Theory of Acids and Bases and its ramifications are presented in quite an elementary manner. The theory is of interest to all types of chemists and the book has been written with that in mind. Three chapters, that is 10, 11 and 12, contain details on catalysis which are of most interest to organic chemists but if necessary they can be skipped without losing continuity.

The historical background of the theory is discussed as well as the details of its use and its application to chemistry as a whole. In the final chapter the authors present their conclusion concerning the function and significance of the Electronic Theory of Acids and Bases.

A word about the authors. W. F. Luder is Associate Professor of Chemistry at Northeastern University and Saverio Zuffanti is Associate Professor of Chemistry, also at Northeastern University.

Science, by D. W. Hill; First Edition, 114 pages; 5¾ by 8¾ inches; cloth; published by Chemical Publishing Co., Inc., 26 Court Street, Brooklyn, N. Y.; 1946; price $2.75.

This book should be welcome to everyone who wants to profit by scientific progress and should be a guide in helping to decide what stand to take in the face of the newest overwhelming scientific developments. It is an optimistic, reassuring volume, explaining that there is no need to fear scientific discoveries, whether they concern an aircraft of incredible speed and almost infinite flying range, or the release of atomic power. The aim of science is to assist and not to destroy mankind.

The author feels that the ordinary man tends to regard modern miracles of scientific achievement with awe and at the same time with profound distrust. He sees in them a continual threat to his peace of mind, the stability of his world and the safety of his person. Not the least of the advantages of the "good old days" was that there was little science and what there was could speedily be checked with the assistance of the stake and a few faggots. In these softer days we are limited to protests against the uses to which scientific discoveries are put or, at most, to demands from Bishops that a period of prohibition should be imposed on scientific research.

The justification of this book therefore, is to try to show that science resembles the law in that the good man has nothing to fear from it and that the chief contribution that science and scientists have to make to the world's welfare has never yet been tried. Dr. Hill has been both an industrial and an academic scientist, having lived in Hitlerite Germany, England and the United States. But here he is concerned with something much wider than the textbook conception of science. He gives a clear answer to those who argue that scientific progress is leading to man's destruction by showing that if the scientific method is applied in the "non-scientific" fields—in religion, ethics, politics, education and leadership—man will learn how to use the technical inventions of science as stepping stones to social and economic progress.

The Decibel Notation Its Application to Radio and Acoustics by V. V. L. Rao; First Edition; 179 pages; 5¾ by 8¾ inches; illustrated; cloth; published by Chemical Publishing Co., Inc., 26 Court Street, Brooklyn, N. Y.; 1946; price $3.75.

This up-to-date and critical compilation of widely scattered data on Decibel Notation should prove valuable to radio, telephone and acoustical engineers as well as engineering students, and to all who work with high-frequency electronics and circuits.

The book was published originally in Madras, India and the American edition corresponds entirely to the original publication. This accounts for the use of some British terms, such as aerial for antenna, valve for tube, gramo-pickup for phono-pickup, etc. This difference in terminology, however, should not detract from the usefulness of this book to American readers.

The subject is developed from its principles assuming no high standard of mathematics on the part of the reader so that the average student of electrical engineering will not encounter any difficulty in understanding and applying the information given in this book. Many solved problems will prove most helpful to the radio and acoustics engineer and students. The book provides a comprehensive survey of the development of the logarithmic unit, zero levels and level signs, decibel meter and decibel graphs, sound levels and phon calculations, etc. which will be welcome to technical workers of the radio and acoustics field.

Atomic Energy in Cosmic and Human Life, by George Gamow; First Edition; 161 pages, 5½ by 8¼ inches; illustrated; cloth; published by the Macmillan Company, 60 Fifth Ave., New York; 1946; price $3.00.

This book which has been eagerly awaited by Dr. Gamow's many admirers, will also be greeted with enthusiasm by all those who are trying to understand the stupendous power and implications of atomic energy.

Dr. Gamow, who is noted throughout the scientific field for his contributions to the theory of atomic nuclei, here presents a comprehensive survey of the development of atomic energy, answering the questions: What is it? Where does it come from? How can it be used? Step by step, from the discovery of radioactivity in 1896 to the present, he describes the theories and experimental methods which led to the splitting of the atom.

Even before the discovery of atomic transformations and the hidden energy of the atom, it had become clear that our sun and all the other stars must conceal some kind of energy more powerful than any already understood. In Part II of his book, Dr. Gamow shows how the relation between atomic transformations and stellar radiation was definitely established. His picture of the evolution of the universe, from a nuclear fluid to its present state, is lucid, convincing and tremendously stirring to the imagination.

George Gamow, the author, is a native of Russia, was born in Odessa in 1904, and received his higher education in the University of Leningrad, 1922-1927. Sent to continue his studies at the University of Gottingen, he developed the quantum theory of radioactivity in 1928, and later did further research with Professor Niels Bohr in Copenhagen and Lord Rutherford in Cambridge, England. In 1935 he was invited to become Professor of Theoretical Physics at the George Washington University in Washington, D. C., which position he still occupies. He was married in Moscow during a visit to Russia in 1931. This is a most excellent little book and we cannot recommend it too highly.

Thermodynamics, by G. A. Hawkins. Copyright 1946; 5½ by 8½ inches; 436 pages; illustrated; hard cloth binding: published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

The author, professor of thermodynamics at Purdue University, has produced here a well balanced treatment of the subject of engineering thermodynamics for those with little or no preliminary knowledge of the subject.

Subjects treated include: the real gas laws; limitations in the use of ideal gas laws; available and unavailable energy: entropy; gas and gas and vapor mixtures; heat transfer; and refrigeration; as well as the fundamental thermodynamic concepts that must be studied. There is a good chapter on combustion, with complete combustion computations, and a rather extensive treatment of the gas turbine and jet propulsion.

In the chapter on vapor cycles are good discussions of the Carnot cycle and extensive treatment of the reheating and regenerative power plant cycles, also of binary vapor cycles. Under refrigeration, both dry and wet compression vapor refrigeration cycles are treated.

Throughout the book the consistent symbols as recommended by the American Standards Association are used. The illustrations are clear and easy to understand, there are steam and refrigerant tables in the back of the book, together with a Mollier diagram, and the book is well indexed.

Mr. Tompkins Explores the Atom, by George Gamow. Copyright 1945; 6½ by 8¼ in.; 98 pages; hard cloth binding; published by The Macmillan Co., New York. Price $2.00.

This book is a sequel to the author's "Mr. Tompkins in Wonderland" and is prehaps even crazier than that book was. Mr. Tompkins, the modest bank clerk, is now happily married, and in the first chapter he and his wife Maud are ready to make their fortune by following a gambling system recommended by Esquire magazine. Physics and mathematics intervene, however, and before you can say "quasi-ergodic systems" Maud is being taken for a tour among the molecules inside her husband's whiskey and soda. In another chapter Mr. Tompkins goes dancing with the electrons of an atom of chlorine and is annihilated in the encounter with a murderous positron. In still another chapter Mr. Tompkins learns the mysteries of the atomic nucleus, watching the tricks performed for him by an unusual person who seems to be a cross between the character of Gepetto from "Pinocchio" and Lord Rutherford.

Professor Gamow, a native of Russia, received his higher education at the University of Leningrad from 1922 to 1927. When invited to become Professor of Theoretical Physics at George Washington University in Washington, D. C., Professor Gamow accepted and he still occupies this post. Dr. Gamow is known throughout the scientific world for his pioneering work on the theory of atomic nuclei.

The Engineer at Law in Two Volumes, by Conde B. McCullough and John R. McCullough, Copyright 1946, size 6 by 9 inches, Volume I—447 pages, Volume II—442 pages, hard cloth binding, published by the Iowa State College Press, Ames, Iowa, price $3.00 per volume, $6.00 for both volumes.

The Engineer at Law, which is published in two volumes, is a Resumé of Modern Engineering Jurisprudence, and has been prepared to bring to the engineer a better basic understanding of and a more profound respect for the law; to acquaint the engineer with those basic necessities which lie behind the technicalities of legal procedure; to discuss briefly the basic principles involved in those certain branches of law which control engineering operations and activities, to the end that the engineer may have a more intelligent appreciation of the problems which confront the attorney; to indicate to the engineer the necessity for so planning and prosecuting his work as to satisfy the technical requirements of the law as well as its equitable demands; to aid the engineer in giving more intelligent service in court or in working up the engineering data necessary for court presentation; and to outline some of the intricacies of legal procedure to convince the engineer of the folly and futility of attemption to do his own legal work.

The above objectives given in the introductory chapter are followed by articles on the Origin and Evolution of American Law; Justice and the Law; Engineers, Engineering and the Law; the Engineer's Contact with Particular Phases of the Law. Other chapter headings are: Courts, Court Procedures, and Systems of Jurisprudence; The Equity Side of the Law; Contracts and Contractual Relationships; Engineering Specifications; Laws Governing Real Property; Torts Incident to Engineering Operations; continuing in Volume Two with: Employment Relations in Engineering; The Engineer in Trial Work as Technical Witness, Councellor, or Assistant; Patents, Copyrights, and Trade Marks; Corporations, Public Utilities, and Carriers; Administrative Law; The Law of Sales; Negotiable Instruments; and Pleading and Procedure.

This set of engineering law books, in addition to being intensely interesting reading for the man with an engineering type of mind, is immediately useful to the professional engineer and can be used to advantage as a textbook in engineering law.

Specifications and Tests for Electrodeposited Metallic Coatings, prepared by Technical Committees representing the American Society for Testing Materials and American Electroplaters' Society, Copyright 1946, size 6 by 9 inches, 52 pages, paper cover, price

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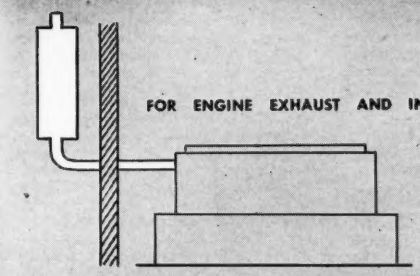

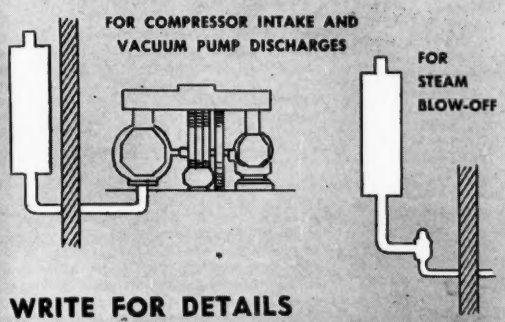

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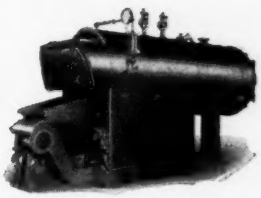

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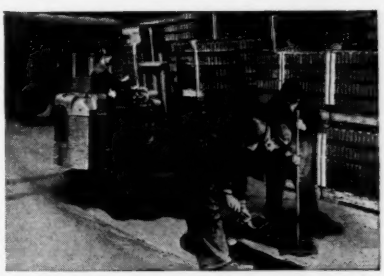

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In the presentation of these standards, the sponsoring societies state that this publication has been compiled to collect all of the ASTM specifications and methods of tests pertaining to electrodeposited metallic coatings on metals so as to have all of them together in a convenient form for the use of the industry. The specifications and methods of test are given in their existing form at the time of publication of this compilation but some of them are tentative with the possibility that they may be changed before adoption as standard and any of them may be revised from time to time as required. The publication contains specifications for electrodeposited coatings as follows: Zinc on Steel; Cadmium on Steel; Nickel and Chromium on Steel; Nickel and Chromium on Copper and Copper-Base Alloys; Lead on Steel and Chromate Finishes on Electrodeposited Zinc, Hot-Dipper Galvanized, and Zinc Die-Cast Surfaces. In addition to these specifications the publication describes methods of test for local thickness of electrodeposited coatings and the testing of salt spray. Also contained in the publication are recommended practices for chromium plating on steel for engineering use, and low-carbon steel for electroplating. The publication should be of extreme value to all electroplaters, particularly those whose work must hold up to specific requirements.

Proceedings of the Mexican-American Conference on Industrial Research, Copyright 1946, size 6 by 9 inches, 176 pages, paper binding, published by The Armour Research Foundation of Illinois Institute of Technology, price $2.50.

This volume contains the Proceedings of the Mexican-American Conference on Industrial Research held under the auspices of Armour Research Foundation, September 30 to October 6, 1945. This Conference was the first to be held on industrial research between any two industrial nations. Its purpose was to demonstrate research in action from pure science at the University of Chicago to the typical laboratories of industry. The position and contribution of the government in national research activities were illustrated by a visit to the Forest Products Laboratory in Madison, Wisconsin. The participation from Mexico was representative of government, with a number of distinguished departmental engineers personally appointed by President Camacho; of banking, of industry and of commerce. Two or three corporation lawyers and the Minister of National Economy were included in the delegation. The addresses and discussions included: The Industrial Research Pattern of the United States, by Harold Vagtborg; Integration of Industrial Research and Education, by Linton E. Grinter; Fundamental Research in College and University Laboratories, by Walter Bartky; The Organization, Management and Effectiveness of Institutional Research, by E. R. Weidlein; The Armour Plan for Industrial Research, by Jesse E. Hobson; Trends in Engineering Education in the United States of America, by A. A. Potter; Industrial Research as Viewed by General Electric, by L. A. Hawkins; The Research Program of Universal Oil Products Company, by Gustav Egloff; The Development and Role of Dairying in Wisconsin, by K. G. Weckel; Investigations in Animal Nutrition, by Edwin Bret Hart; Breeding, Feeding, and Management of Dairy Cattle, by E. E. Heizer; Pasture Problems, by L. F. Graber; Research in a State University, by I. L. Baldwin; Agricultural Research Serves the Public Welfare, by Noble Clark; The American Standards Association, by George S. Case; The National Bureau of Standards, by E. C. Crittenden; The Value of Standards to American Industry, by David Levinger; Science, the International Language, by Arthur H. Compton; Newer Developments in Medicinal Research, by E. H. Volwiler; Technology on the International Front, by Maurice Holland; The Management of New Industrial Enterprises on the International Front, by George H. Houston; Financing New Industry on the International Front, by James Drumm; and Discussion by Mexican Guests. Industrial research as a profession is young in years, but co-operative conferences such as this are bound to have beneficial results on the economy of the nations participating in such conferences.

ASME Boiler Construction Code, 1946 Edition, by the Boiler Code Committee of ASME, published in either one combined volume, price $12.50, or in individual volumes as follows: Rules for Construction of Power Boilers, Sections 1, 6 and Appendix, price $2.75; Materials Specifications, Section 2, price $3.50; Boilers of Locomotives, Section 3, price $1.00; Low Pressure Heating Boilers, Section 4, price $1.00; Suggested Rules for Care of Power Boilers, Section 7, price $1.25; Miniature Boilers, Section 5, price 75 cents; Unfired Pressure Vessels, Section 8, price $2.00; Qualifications for Welding Procedure and Welding Operator, Section 9, price 90 cents; Boiler Code Interpretation Service, loose leaf, subscription $5.00 annually. Above prices to non-members, 20 per cent discount to ASME members. Separate sections; varying numbers of pages; illustrated; size 5½ by 8 inches, paper binding. Published by the American Society of Mechanical Engineers, 29 West 39th Street, New York.

Here is the complete 1946 edition of the ASME Boiler Code, superseding all previous editions. As all power engineers know, the majority of the states in the country have adopted the ASME Code as the governing code in connection with state regulations governing the design, maintenance and operation of boilers and many municipalities have also done this. Those states which have their own boiler codes have adopted provisions so nearly like those of the ASME Code that the latter may be said to be universally accepted. Every power engineer should see that he either owns the appropriate sections of the Code that he will need, or has them available

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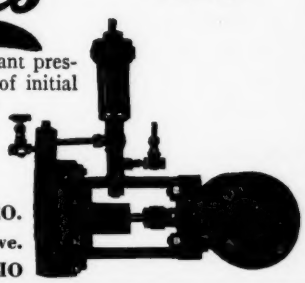

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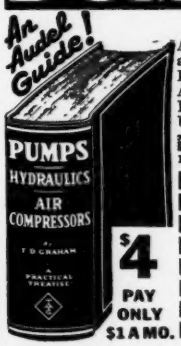

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The 1946 edition includes many of the recent revisions and interpretations representing not only the highest degree of safety, but considering advancements in design and material and the evidence of experience in operation. The various rules have been formulated to afford reasonably certain protection of life and property and to provide a margin for deterioration in service so as to give a reasonably long safe period of usefulness to boilers and pressure vessels.

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The increase in recent years in the number of small boilers in use for various purposes, has made it advisable to issue a section on miniature boilers of 20 sq ft water heating surface or less and for 100 psi maximum allowable working pressure.

Suggested rules for the Care of Power Boilers discusses routine operation, such as putting boilers in service, handling boilers in service and out of service. Rules for operating and maintaining boiler appliances are given, also rules for inspection and partial rules for instalation. Prevention of direct causes of boiler failures receives considerable attention. An appendix to this section gives details of feedwater analysis, treatment and control and instructions for check tests in the field.

Section 8 on Unfired Pressure Vessels covers details of construction of heads, joints, manholes, openings, welding and the like, with methods of calculation of joints, openings, connections.

The Federal Labor Laws, compiled and edited by the Staff of Executive's Labor Letter, Copyright 1947, size 6 by 9 inches, loose leaf binder, published by National Foremen's Institute, Inc., Deep River, Conn., price $2.50.

This manual for supervisors on the Federal Labor Laws is designed to give the needed help and present information about Federal Labor Laws which every foreman should know. It offers the basic knowledge necessary to keep the company's slate clean and to avoid tangles with inspectors and the courts. The new and compact 100-page Second Edition of the manual explains the most important aspects of the Wagner Act, the Wage and Hour Law, the Walsh-Healey Public Contracts Act, Unemployment Compensation and Old Age and Survivors Insurance, the Employment Service, the GI Bill of Rights, Veterans Reemployment and Seniority Rights, The Fair Employment Practices Committee, the Railway Labor Act, the Railroad Retirement and Railroad Unemployment Compensation Acts. Also included are all Congressional amendments to date, together with revisions based on new agency regulations or caused by major court rulings. The railroad laws, which also apply to airlines and express companies, are an important new feature of the book. The manual is prepared to be of aid to men who have charge of departments and direct the work of employees, and should be of considerable assistance in not only avoiding trouble but in keeping operating costs down.

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